UNIVERSITI TEKNOLOGI MARA

Professorial Lecture UiTM
Professor Ir. Dr. Ismail Musirin

Power System Security | Appreciating The Presence of Artificial Intelligence

Program

Professorial Lecture UiTM

Dewan Seri Impian, Hotel UiTM

3 Oktober 2024 (Khamis), Jam 9.00 pagi

Nama	Professor Ir. Dr. Ismail Musirin
Tajuk	Power System Security | Appreciating The Presence of Artificial Intelligence
Jangka masa	: 2 jam 17 minit

Transkrip:

1:09:12 : Assalamualaikum warahmatullahi wabarakatuh dan selamat sejahtera kepada semua hadirin yang dihormati. Pertamanya saya ingin ucapkan kasih syukur kepada Allah subhanahu wa ta'ala kerana akhirnya saya dapat menyiapkan buku saya seterusnya menyampaikan syarahan profesor saya pada hari ini yang telah saya tulis dengan tajuk yang berbunyi sebagai Power System Security Appreciating the Presence of Artificial Intelligence yang telah diterbitkan oleh UiTM Press. Terima kasih kepada UiTM Press juga. Terima kasih kepada semua hadirin kerana dapat meluangkan masa bersama pada pagi ini yang sungguh hening untuk meneruskan syarahan saya pada hari ini. Saya mohon izin untuk beralih bahasa dan bicara saya pada hari ini kepada bahasa Inggeris kerana saya sudah menyediakan slide dalam bahasa Inggris. Ladies and gentlemen, I'm going to talk about our system security, appreciating the presence of artificial intelligence.

1:10:17 : So I will be talking on four main topics. The first one is power system, and understanding the artificial intelligence, followed by intelligent distributed generation, installation in voltage security improvement. Distributed generation, in Malay we call it as penjanaan, penjana agihan. Artificial intelligence-based techniques in optimal dispatch in power systems, followed by the last one, integrated artificial intelligence-based under-voltage load-shedding for secure power system operation and planning.

Let's go to the first one. So we are actually connected to several countries in Asia.So for your information, we in Malaysia, Peninsular Malaysia in particular, we are connected at the bottom part of Peninsular Malaysia to Singapore. The utility for Malaysia is TNB. At the bottom part of Peninsular Malaysia, we are connected to PUB, Public Utility Board of Singapore. That means we can buy or sell electricity to Singapore and the other way around. At the top part of Peninsular Malaysia, we also have connection with EGAT, Electricity Generation of Thailand, EGAT. And we are connected from Klangmeh at the southern part of Thailand to Gurun Kedah.

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	:	So when you go to Gurun Kedah, when you go to Kedah, you can see HVDC transmission because the supply in Malaysia is 240 volt RMS, root mean square, and at the top part, at Thailand, the supply there is 110. So we are having 240, they are having 110, but they are having HVDC transmission from the top part of Peninsular Malaysia to the bottom part of EGAT at Thailand.
1:12:18	:	So from the maps, you can also see that we have connection between Peninsular Malaysia at the left side of this map to the right side of the map, which is having Sabah at the top and bottom we have Sarawak, and we also have connection from Malaysia to Brunei, Malaysia to Philippines, and then Philippines going to Vietnam, Laos, Cambodia, Thailand, Myanmar, Malaysia and Singapore. So based on my discussion with Professor Halim, he was a professor in UM. So he did mention to me that, so we sometimes we buy, we sell electricity to EGAT Thailand if they got power outage or power shortage. On the other hand, we can also buy from them if we discover or we experience the lack of power electricity to the consumer. Okay, today for this slide, I would like to talk about utility.
1:13:25	:	Utility means the supplier, supplier of electricity in Malaysia. In Malaysia, we have TNB. TNB is the utility of Malaysia and we are actually practicing vertical power system. Something ought to be there. So vertical power system means, we have only one company who will manage the distribution, transmission of electricity for the whole country, Malaysia. So unlike other countries, unlike the developed country like US, Japan, and then Italy, some other countries, they are practicing deregulated power system whereby the power can be experiencing, the utility can experience up and down electricity tariff. They can have fluctuating of electricity. So it depends on supply and demand. So if you go to UK, you go to Italy, you will see that the price of electricity is not the same in the beginning of the morning until during the peak hours in the afternoon or maybe in the late night. You can confirm this with Prof. Nofri, energy expert in UiTM, Prof Nofri. That is in Malaysia, and then another utility for Malaysia, which is located at the right part of the Malaysian map, we have Sabah.

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: The utility is SESB, Sabah Electricity Sdn Bhd. SESB is actually a combination between TNP subsidiary as well as Sabah State Government. But for Sarawak, the electricity supply is being supplied by the Sarawak Energy. So Sarawak Energy is basically the company owned by Sarawak State Government.

Okay. Then at the bottom part of this diagram, of this one, you can see that utility involving generation, transmission, distribution, and also load.

So generation, our close neighbor, UiTM, you go direct, you go outside, go to Bahasa Pusat, Bahasa Korea, APB, you go straight, you will see Padang Jawa. Padang Jawa, you go on the junction, you turn right, and then close to Petronas, that one is Jalan Dato' Haji Sidin. You turn left, you go straight, you will see river. That one is Klang River. There is a power station over there. The name of the power station is Connaught Bridge Power Station, owned by TNB. If I'm not mistaken, the capacity for that one, that power station, is about 900 megawatt, if I'm not mistaken. That is number one, close to UiTM. And then you go on your way to KLIA, on the way to KLIA, and then you turn left, go to Banting.

You will see Bukit Changgang, you know, Bukit Changgang. You will see a factory, paper factory. That one is, we have another one power station owned by Lim Goh Tong, Tan Sri Lim Goh Tong, the owner of Genting Island.So we have a power station there. That one is called as Kuala Langat Power Station, or we also call it as Genting San Nian Power Station. The capacity is about 270 to 720 megawatts.

1:16:45 : And then on the way from SKVE, South Klang Valley Expressway, SKVE, from Kampung Lumbung, and then going to Uni10, from Isang. And then on the right side, you will see KBDT. Behind KBDT, you will see another power station. That one is called as Serdang Power Station, or Putrajaya Power Station, owned by Tenaga National Berhad. That one is owned by the government, by TNB. That's number three. And then number four, on the way to Kapar. Kapar, you will see another one big power station.

We call it as Kapar Energy. Kapar Energy is actually owned by Malakoff, if I'm not mistaken. Segari Power Station. So capacity is quite big. 2,500-something. 2460 megawatt, if I'm not mistaken. That means if something happened to Kapar Energy over there, we will experience a power outage in the whole peninsula. Later I will talk about load shedding and so on. So that is basically the general overview of utility in Malaysia.

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1:16:45 : And then going down, you will see generation, transmission, distribution, load, and so on. This is actually a map to show that you have Tenaga National on the left-hand side of this picture. And then you will see Sabah at the top of the East Malaysia. And then at the bottom, you see Sarawak. In between Sarawak and Sabah, you see our neighbor, Brunei. So all the numbers there, 1327 megawatt, is actually the installed capacity by SESD. And then for Sarawak, 3650 megawatt is installed capacity by Sarawak Energy. And Brunei, they have 806 megawatt as their installed capacity. And on the left side of the map, you can see Tenaga National as well as Singapore, and also you can see the red color. The red color represents the installed capacity of the country. At the bottom part, you can see FY 12 year 1, year 2012, 2013, and so on.

This is basically the project whereby you can have, at the pie chart there, you can see gas, low-pressure natural gas, coal, hydro, others, oil, and distillate. So in electrical engineering, the concept is quite straightforward. You have a prime mover. Prime mover, in Malay, we call it as penggerak utama, prime mover. You go to lab in our faculty, we have induction motor. Induction motor is actually one of the prime movers available in our lab.

Then the prime mover will be decoupled, will be coupled by, will be coupled by the, with the asynchronous generator. So when the prime mover moves, it will create flux, cutting of flux, and then at the end of the day, it will basically generate electricity, and of course it will have equation 4 of n, 4, 4x n,x n x flux, x kp, kd, and so on. So no worries about that equation at all.

1:19:51 : So just to share with you here, so this is actually the general grid network which I extracted from Tenaga National. So you can see on the very top there, top left, you'll see power plants. So in power plant in Malaysia, normally in Malaysia, we are generating 25 kV or 20 kV based on the capacity of the synchronous generator. So that means our electricity will only generate 35 kV or 30 kV, and then after that, it will go through a substation. In the substation, you can see a substation close to UiTM Hotel over there.

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: So that one is actually a substation.So the substation will step up the voltage level from 35 kV into maybe 500 kV or 275 kV. That one is actually a substation of Pencawang Utama. And then for a substation, you go through a transmission tower there, and then you will see, that one is called National Grid of Peninsular Malaysia and go to another substation, and then you will see 132 kV. 132 kV is actually voltage which needs to be accommodated and needs to be compatible with the transmission line. So from the substation, the voltage level, maybe 500 kV or 275 kV will be stepped down into 132 kV, and it is going to supply electricity demand at large power consumers. And then going down a bit, you will see 11 kV. Voltage will go down a bit. So we can tap the voltage level from transmission system. So in Peninsular Malaysia, we got from Johor Bahru at the bottom and Kedah or Penang placed at the top of Peninsular Malaysia. The whole thing, we call it as National Grid of Peninsular Malaysia. Okay. And then we go down a bit. Again, we can see another substation. The voltage level is going to be 240. So the voltage level at the socket and over there is single phase. The voltage is 240. That one we call it is effective voltage, RMS, root, mean, square voltage. Now what is the equation? You will have integration and so on and so forth.

1:21:53 : But on the other hand, you also have three-phase system, and nowadays, in Shah Alam especially, they normally have three-phase meter whereby you got RYB. If your house, you have RYB, you got four cables. So that means you will require three-phase system. Okay. This one is actually a setup, a picture to show the connection from power generation to the heavy industries, light industry, small commercial and residential.
So from 35 kV go up to 275 kV, 400 kV and so on. And at the end of the day, it will go down to 240 V or 415 V. Okay. So the picture there, you can see 400 kV. So if you go to KLIA, you can see so many cables there. So KLIA is actually receiving supply from many incomings because we would like to make sure that KLIA is working smoothly. So they need to make sure that the supply will not be discarded when something happens to the system. And of course, in between all this, you will have transformer. Transformer is actually a transformer. We watch a movie.

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	:	We watch cartoon named Transformer. Transform from car into plane into robot. Transformer. But in electrical engineering, transformer is defined as a device or equipment which will convert voltage level from low-level voltage to high-level voltage within the same frequency, 50 Hz. We are having 50 Hz frequency. But if you go to Thailand, the supply voltage there is, if I'm not mistaken, 60 Hz. Japan, you can have 60 Hz. U.S., you can get 60 Hz, 50 Hz, and so on. Okay. Until at the end of the day, you will be going to receive 240 volts for commercial and residential area to cater the light industry, medium factories, and so on.
1:23:51	:	Okay. I would like to share something with you based on our experience in Malaysia. So we have 29 September 1992. We experienced a quite bad power outage or power blackout. The total power blackout across Malaysia due to lightning striking, independent power producers was initiated at that time.So it happens total blackout. So if you can flashback many years ago or maybe 25 years ago, 1992, so the total blackout will affect everything in Malaysia. And then the next event happened in 3 August 1996 involving Peninsular Malaysia starting at 5, 1770, and it was restored in 11 p.m. So you can imagine, we got power outage or power disconnected or simply blackout.Imagine you turn off this one, we are in the middle of the darkness. Okay. So from 5 o'clock into 11 o'clock, how many hours there? Six hours with no electricity. Electricity is something which we cannot see. But if you don't do it correctly, so you will experience short circuit. So the difference between short circuit, electric shock and electrocution.Electric shock is kejutan elektrik. Electrocution is renjatan elektrik. So electric shock, inshallah tak meninggal dunia. Renjatan elektrik, inshallah boleh membakar tisu-tisu in our body system. The difference between electric shock and electrocution. Then we have exact date, 2005 affected state, Perak and so on.

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1:25:34 : I would like to share something with you. I'm not sure if I'm not mistaken, 2005, we got a very bad power outage during that time the Prime Minister was stunned, Tun Abdullah Badawi. He was having a meeting at Putrajaya and something happened to Kapar Energy. The sulfur hexafluoride, SF6, the pressure of the insulator went down to less than the acceptable limit. So what happened is that the production system failed, then burned off.What happened is that when you have power outage, then we need to disconnect 2,460 megawatt, for example, if they have got that capacity. And you can imagine, many places, many states will experience power blackout. So there is a term which we need to understand here.
The term is load curtailment or load shedding, which I'm going to talk about this one now. And this one is also done by one of my graduate students, Saiful Vidal. Yeah, okay.So we call it as load shedding or load curtailment. We need to turn off the load. That means we turn off some of the loads here. All right. What happened is that during that time, TNB need to make a very brave and fast decision. So TNB experience, TNB make addition, make addition to turn off the load, we call it as load shedding. So they turn off Putrajaya, they turn off Selangor, they turn off Negeri Sembilan, and then Melaka, until Johor. So this is called as load shedding. So in order to turn off, make it intelligent, so we need to apply artificial intelligence, which places need to be turned off, which places need, how much need to be turned off, and so on.

1:27:23 : This one is called as load shedding. This is models. Unlike power electronics in electrical engineering, our research is a bit different. In power electronics, you can see the connection between transistor, IGBT, and then you can see control circuit topology and so on. But in power system, we are talking about the whole model right from the bottom part of Peninsular Malaysia to the right part of Peninsular Malaysia. But need to understand that it is very dangerous if TNB were to allow researcher to use their system very dangerous. So that's why we, in power system, we use this power system model. So we call it as single line diagram of IEEE, 24 bus RPS. RPS stands for reliability test system. So that means if you develop new technique, you develop new model, you develop new algorithm, you need to test into all this RPS system.

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: So if your technique is working well, insya Allah, normally, conventionally or technically, you can accept that this one can be, will be able to work well also practically. So on the left-hand side, you got IEEE 24 bus RPS. On the right side, you got 30 bus RPS, and then you also have 57 bus RPS. And even you have 118 bus RPS. In Malaysia, right from the bottom part of Peninsular Malaysia up to top, to the top part of Peninsular Malaysia, we got maybe 240 something. For example, 240 buses in Malaysia. This one is a radial system. When we talk about radial system, we need to understand that you got a supply from TNB.

1:29:11 : And then you got a substation.Substation will basically power up all the loads here. So this one is basically the supply. Single source. Unlike this one, you got many sources, right? You got many sources. This one, you got only single source. Single source. And this one is called as IEEE 30 bus radial distribution system RPS. If you go out from our parking lot, you will see a substation over there. That one is actually a supply which is actually tagged from TNB. And the substation is going to supply the whole of UiTM, from Hotel UiTM going down to Pusat Islam, the Bangunan Wawasan until Pusat Bahasa. Okay? So this one is called as radial distribution system RPS. You got 33 bus, you got 69 bus, or you can have also 118 bus RPS radial distribution system.
Let's talk about compensation scheme and relevant objectives. So this one, this figure is trying to show that you got several schemes or several initiatives which need to be done. This is a real story. If you go to the TNB transmission at Jalan Bangsar, there you will see a department. They got NLDC, National Load Dispatch Center. National Load Dispatch Center will determine, okay, Genting Sanyen, tomorrow you generate this much power. Okay, KAPAR Energy, you generate this much power and then, Karnak Bridge, you generate this much power and so on. So in order to do that, they need to have the decision.

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1:30:47 : So we can have optimum electrical power dispatch. So it's a process to compensate voltage and so on so that the voltage can be improved, the loss can be minimized, and other than that, you can have fetch devices, and then you can have lasso tap changer, and all those are called as compensation schemes, which also require optimization technique. And when we do optimization technique, we are going to use artificial intelligence, or in general, you can call it as computational intelligence technique, and then you can see that this one will be connected to power system network. Then it will perform optimization process, and of course, we will see objectives. So when we do optimization process, you will see objective function, fitness, and so on. So that's why it is quite sensitive. If we talk to AI people, if they say that I am going to do optimization, so the next question will be asked to the candidate will be, what is your fitness equation? What is your objective function? What is your control variable? Then the students will start shaking if they cannot answer. So because this is really artificial intelligence, and really an optimization process which needs to be involved, which needs to be done to power system network or anything.

1:32:23 : Okay? So when we talk about optimization process, in layman's terms, we call it as optimoman, read by Dr. Zuhani just now. Optimization process, you will have two modes. Number one is single objective. On the right side, it is actually called as multi-objective. So when you do multi-objective, you will see weighted sum technique. That means you linearize equation.The equation will become F total equals to alpha 1, fitness 1, plus alpha 2, fitness 2, plus alpha 3, fitness 3, until alpha n, fitness 10. That means you can do many things at the same time. On the other hand, we can have parietal front a bit tougher than the weighted sum.
Okay? And then when we talk about multi-objective, single objective, of course, we need to understand the basic term. When you do optimization, you need to understand control variables, fitness equation, objective function. If you remember, in our math, maybe 30 years ago, 30 years ago, 35 years ago, or maybe how many years ago, if you get equation y equals to 6x minus x squared, it's going to be like a half curve equation. The y is actually a fitness function.

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	:	The x is the control variable. So objective function is to maximize or minimize y. That is one simple equation.Can you imagine you got mechanical engineering performance or engine performance? The engine performance can be translated into several equations. Maybe the car engine, the fuel component, and then the temperature, and so on. All this can be translated into equation. In the equation, then you can get single objective or multi-objective. This is basically a model in power system network. This one, FBSI, it stands for Fast Voltage Therapy Index. This is an equation which I developed during my PhD time. I developed 35 equations during that time, but only this one is actually reliable because the rest have been developed by other professors in Malaysia.
1:34:21	:	And I discussed with my supervisor, my logbook is very thick. I think three, four books. We got a low-flow equation there, and then we got FBSI. Surprisingly, in 2005, I went to Portugal. I went to Portugal. I attended a conference, and when I reached the front desk, the professor, I remember Professor Ana Madureira from Portugal, Lisbon, Portugal. Professor Musirin, thank you very much for your attendance this morning. I'm very happy to have you here. My student will be coming to me tomorrow. She said that. During that time, we don't have handphone, so I cannot prove it because I got no handphone during that time. No smartphone. Okay. Then, the next thing, a Master's student from the bottom part of Lisbon, Portugal. I think her name was Claudia. She used my equation FBSI. If you go to Google, alhamdulillah, not to brag, but just to share experience, this one has received about 400 or 500 citations just for this equation alone. And surprisingly, this student is using my equation in her research. So I talked to her, and this is the way, this is the power flow, and so on. It was 2005 in Lisbon, Portugal. And then, this equation can be expanded into something else. This one can be expanded into power threshing, which has been developed by Dr. Zulkifli Abdul Hamid. He developed another expanded equation from the FBSI equation, which I developed. And until now, it's still hot, alhamdulillah. Still acceptable, but we need to make a comparative study with others.

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	:	Other than that, you can go to, this is written by Likwi in Princeton University, Australia, page number 18. He put my name there because he used my equation. Yeah, Likwi, and also you can go to another PhD student. I forgot about the year. He got PhD from A&M Texas Medicine, USA. He also used my equation as a comparative technique, and he developed FBSI, and so on. So you can see that basically the equation can be used. This one is basically having several lines. So let's say this is busbar. Busbar is actually like a computer hub. Busbar, load bus. You got transmission line. You see Shah Alam going to Klang. Shah Alam going to Subang Jaya. Shah Alam going to maybe, maybe going to Puncak Alam. You got three lines. So all these three lines or all these three transmission lines will have all the three FBSI equations. So that is actually the beginning of the FBSI. This is another term which I need to share here. We call it as maximum loadability. That means the TNB need to understand how it's going to be the maximum load to be, which can be sustained by this load. So the longer one, the longer one will make sure that this one is going to be called as, the longer one is called as the secure bus, and the shorter one called as the, as the big bus. Okay.
1:37:29	:	Let's talk about AI. Artificial intelligence. Are you all okay? Thank you very much for listening. AI, when I did my PhD, in the beginning of 2001, I write, I wrote an email to Professor Fogel, and he was the one who developed evolutionary programming, and I wrote this. I read his book, and according to him, according to him, during that time, during that time, not now, during that time, AI is subdivided into three main components. The first one is fuzzy logic. Fuzzy logic is a technique to make a decision. The expert here is Professor Ina. Okay. The second one is evolutionary computation. Evolutionary computation for optimization process. And third one is artificial neural network. So NN will be used for prediction, but evolutionary computation will be used for optimization process. Okay. So examples of application. For NN, we can use NN to predict disease, to predict types of fruits, to cluster types of wood, to classify banana redness.So that means you need to convert everything to numbers. Let's say you would like, you would like to predict types of diseases. That means you need to get data from the hospital.

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	:	That means you need to take maybe 100 data from 100 patients, take the blood, take the blood results and so on, and then convert into equation, convert into variables and so on. So output will be, number one maybe, target output one could be Japanese encephalitis, two diabetic, three could be dengue, four could be hypertension and so on. So that means we will require data.
1:39:24	:	This is one application and then ANN is also used for prediction forecasting. It will require historical data, requiring training and testing data and we can also write our own codes or you can now use MATLAB toolboxes or block set to solve our problem. How to start using ANN? ANN is actually quite flexible. If you are coming from architecture faculty or college alumni, just imagine if you would like to talk about satisfaction level of a customer or contractors, as long as you can get data, many data and then convert into variables, you know X1, maybe the financial status and then the project number and so on, output will be satisfaction level of the contractor. Let's say you talk about satisfaction level for students in education faculty. Also you can have that one to be applied, which we can also use in end or AI. Understand what need to be collected, understand what variables to be used and collect data and divide into two groups for training and testing data. This is black box. It's a black box. You train them and then you train the black box so that the black box will learn and understand at the end of the day it will be able to predict. This one is one example. Output is to basically predict type of fruits, orange, durian, apple, grape and so on and of course in the incoming one you can see the input variables, size, weight, smell, appearance, taste and so on. I will talk about fuzzy logic components. These are all components which you need to understand in fuzzy logic components, membership function, rule-based inference, engine fuzzification, rule evaluation and list fuzzification. Let's talk about evolutionary computation. It is going to be used for optimization process, need to develop programming codes and in the beginning they have evolutionary programming, they have evolutionary strategy, they have genetic programming and genetic algorithm. It was in the beginning.

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1:41:39 : When it comes to knowledge expansion, can you imagine Allah has given us brain and these people think, understand and convert into mathematical equation. I would like to show you one example, particle swarm optimization. It was developed by Eberhard and Kennedy. Eberhard is a psychologist, one of those. The other one is mathematician, sorry, engineer. Engineers sit with psychologists, understand the behavior of fish and behavior of birds and they are able to convert this into equation and try to solve problem involving power system or even computation problem.

So you can see the beauty of artificial learning. Ant colony, ant, some more. Ant colony optimization, you can see flower pollinated, bee colony, bee, lebah, ant colony, particle swarm, antlion, gravitational search algorithm, multi-vere, cuckoo search, firefly and so on. All those are basically based on insect. So the scientists, the computer intelligence people convert this, convert the behavior into equation and try to solve power system problem involving power system, maybe computation and so on. On the last one here, quadratic programming, linear programming, sequential programming, they are all the basic traditional mathematical optimization techniques. You can see the C, white, or the snake algorithm, snake, snake ular. The algorithm random walk and tabu search is actually moving randomly, propagate. Propagate in the way we call it as merambat, propagation, merambatan. So the behavior of a snake, people try to convert the behavior of snake into equations and try to solve power system problem. You can also do that. Okay, this is actually the ringkasan, the summary to talk about ANN, fuzzy logic and evolutionary computation.

1:43:40 : Can I go to the next one? Are you still okay? Okay, thank you. Let's talk about compensation schemes or initiatives. So in power system, we will talk about, just now I talk about objective function and compensation scheme or initiatives. At the top, you can see optimality power dispatch, power scheduling and so on. Power scheduling means the TNB need to schedule how much power need to be generated by this power system or power generation, power plants.

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Transkrip:

	:	So this one we call is power scheduling, aAnd then load scheduling, people need to turn off some of the loads like turn off the load here. And at the bottom part, you can see the objective function. This is only a picture to show the sub-components involved in the distributed energy resources .You got distributed generation technique and energy storage technologies. So battery and so on. Okay. You can see PV, you can see wind turbine, you can see biomass, hydro turbines, PAFC, SOFC, MCFC, and so on, fuel cell. All these are basically sub-components in distributed energy resources. And DG, when you talk about DG, distributed generation, you will have four types. People talk about our PV in Gambang Selangor from SRI. So DG, PV or solar is actually one kind of distributed generation, but this is type one category. Type two category, deliver active power only.
1:45:07	:	Example, synchronous compensator, KVR compensator and capacitors. Type three, deliver both real power and active power. That means when we compensate, when we connect this DG into our system, they will supply two things. The Pd and Qd is actually real power. Q is active power. You talk our electrical city, electricity bill. The definition is kilowatt hour, KWH hour. That means time times the power, and type four is deliver real power and consume the active power. This is only kind of load. You've got constant load, industrial load, residential and also commercial load. All right. This one is actually a picture just to show from a power system model on the left-hand side over there. It will be connected to this one on the right side. You've got medium voltage level and low voltage level.You've got voltage decay, current increment, losses increment and so on. So all this will basically require optimization process. Can you imagine? Capacitor bank is very expensive. You can talk to Dr. Murthada. He has project in JKR and he has to spend $100,000 to buy a capacitor bank. Maybe. So in order to do that, they need to do optimization process so that we will choose correctly the places and the sizing of the capacitor bank. That's why it is not something it is something very real and very practical. That is the involvement of AI into power system in this case.So then you talk about PV, you talk about solar, this is the story. Okay. When you want to do your research in digital generation, we can have choices.

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: You can, if you don't have money, you can just simply add one DG or two DGs or three DGs or up to you depending on the capacity or the capacity of the country or the utilities or the company. And then you have test system, 33 RDS, 69 RDS and then you can have many choices. This is the DG solution scheme in distribution system and then next one I will talk about DG in solution system scheme in test system.bYou've got single DG, two DGs, three DGs and so on depending on the research. Okay. So you can also combine. You can also combine whether you can combine between DG tech one and DG tech two. That means you can combine between PV as well as the synchronous generator depending on the requirement of the research scope and at the bottom there you can see 30 bus, 57 bus, 118 bus and also 300 bus and this is another approach for DG installation. Okay.You can have several things. You can have several scheme so you can have several. Of course, this one will also involve a programming language.

1:48:03 : Programming techniques you need to write programming codes and then they can choose how many units they need to do and so on. Okay. What is this picture? This one is actually a picture. A plot. We call it as random plot. In the beginning in AI we generate random numbers. We call it as initialization. Initialization when we generate random numbers these numbers are going to be very random in nature. So let's say you would like to install 3DG so 3DG will have three control variables and location will have three control locations then you will have six control variables.
These are all random in nature. What happens is that after sometimes this one this one become optimal optimal solution that means if you are an engineer you give this one to TNB transmission department okay boss this one we have done the optimization process and this is going to be the optimal value which need to be installed into these places and this going to be the cost and so on. That is actually the beauty of optimization process.

Program

Professorial Lecture UiTM

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1:49:17 : Next one I would like to talk about AI based technique in power system. The story is like this. We got generators and then energy and power station.In order to reduce the cost of generation we need to do optimization process okay but if they want to do compensation technique or compensation scheme they need to do something adjusting the ADC. At the generators they got QGC1, QGC2 and so on. So this need to be determined or need to be identified using optimization process.
This equation is only simple equation power equation and index equation. No worries this is only the algorithm. How it goes but of course you need to have this one right. So this is the flowchart for ICA-MEP technique developed by my PhD student. ICA-MEP stands for integrated clonal accelerelated mutation evolution programming. If you Google this you're not going to be in Google because something normal.Submit the title and the is something different. CCS stands for composite composition strategy. So you will concentrate on the power to be adjusted at the generator process.At the same time we can also have generation which can be done on the load process. So this combination we call it as CCS composite composition strategy. So we call it the combination between ORPD as well as DG.

1:51:11 : Next one I would like to talk about composite, composition strategy involving the DG and then ORPD and last one is the integrated so we call it IDG-ORPD. So in the middle part, the green part, you can see location one, location two, location three and so on. So those are all the random numbers in the beginning in the first place and then it becomes optimized. One common value for the whole control variable. This is only going to talk about optimization technique and then I mentioned about function and so on. The same thing is the plot to show the profile improvement when you have several techniques involving ORPD. So you can have several lines and you have loss. This is the loss profile. Again, this is random number.The random number is representing QG2, QG5 and QG8. Number 2, number 5 and number 8. Eventually it becomes optimal. From very random, from very different, it becomes only one value.That one is called optimization technique. That's why it's sensitive if people talk about optimal but if they don't know, they don't understand or they don't use the equation, that one could be very sensitive.

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1:52:58 : This one is talking about integrated AI for secure power system operation and planning.This is to be my last part of my lecture today. So intelligent load sharing scheme involves optimal location and sizing for PD and PV. This is a federal highway on our right side and our left side from that side. So section 5, 6, 7 until section 12 will be on the right side of the highway. From here on the left hand side, section 15, 16 until and so on. So in power system, if we were to do load sharing, we need to take the data from this system and need to run process whether we are going to involve these places to experience load sharing or vice versa. So you need to apply optimization technique involving sizing and location. That's why you got optimal location sizing. Let's say TNB. TNB said, okay, engineer, I want you to turn off load at Sijangkang, example. One in Sijangkang and one more in Subang Jaya. So three places, non-location. So they cannot simply turn off how many houses, no. They need to run optimization process. Non-location, optimal sizing and last one is optimal location and sizing for PD and QD. This one is only numbers. The load from 5 to 25 megawatt and then you got location. This one will be given to the vendor or the engineer and they will identify this location, okay. The location will be this places and then the sizing will be this one. And when we do research in power system, of course, not only power system, when we do research, especially at the master's or PhD level, we cannot run away from doing the competitive study, okay.

1:55:17 : When we do competitive study, we would like to make sure that our proposed technique in this case is ERSEP. ERSEP is embedded real swarm eversion programming. So we integrate between particular swarm and eversion programming so we call it ERSEP. Okay, so you can see that we win. So it managed to get the lowest value of power which I have put in the box here. So that is actually the beauty of our proposed technique in this case.As a conclusion, power system security is crucial for power system community as it ensures the reliable and smooth delivery. Number two, the integration of optimization processes involving AI is essential to prevent issues of under compensation or overcompensation. Under compensation means like this.

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: We buy something, we install a capacitor bank but the voltage is still low. Overcompensation, we do something, inject capacitor bank or install capacitor bank but voltage is very high. There is also something unwanted, undesirable.There was overcompensation. Okay, distributed generation, installation, optimization power dispatch and optimization load shedding are three compensation initiatives that ensure power system security. And last one, any developed techniques can be feasibly implemented in other research areas subject to appropriate modifications.