Understanding GPS and Synchrophasor Technology in Power Systems

Created with Smart Noter

Speaker 1 00:01

Okay.

Speaker 2 00:01

In the receiver, if there are more than four equations here.

Speaker 1 00:06

Okay.

Speaker 2 00:06

And I'm interested in finding xi, yi zi and delta T. I need minimum four, but if I have more than four, I use least error square and I can calculate the clock error more accurately because I have better situation. Okay, so why it's called pseudo range. As I already explained, time received is based on the receiver's inaccurate clock. So it's actually offset by delta T times speed of light. That's why it's called it's pseudo. It's closed, but not the real distance. Okay, so what the receiver actually does in a nutshell, captures the signal from each satellite.

Speaker 1 00:54

Right?

Speaker 2 00:55

Each signal has a time stamp.

Speaker 1 00:58

Okay.

Speaker 2 00:58

Then receiver loads when it thinks it receives the signal, computes the pseudo range, uses the four equations minimum and calculates the clock error.

Speaker 1 01:11

Okay.

Speaker 2 01:11

Find the three D and the clock error. Once the clock error is known, you can compute the pseudo range. Correct the pseudo range and receiver will know its true distance. Okay, so just to give you a, you know, idea example, let's say you know, take two D, for example, xy, no altitude. I know jet. Right. So if that's the case, I use four satellites. A, B, C, D. The position of the satellite, the time sent in microseconds, and the time received based on the receiver clock. So, first step using this data is to compute pseudo range using speed of light. Pseudo range is time received minus time sent. So for each satellite, I compute the pseudo range. It's for example, for satellite A, the difference is time received and time sent. Right? Time received, time sent are all there.

Speaker 1 02:26

Right?

Speaker 2 02:27

So it's three times one point zero zero four. Right. Because if you look at the difference between the two. Right. So this way I calculate the pseudo range. Then I use the four three equations in this case, right? I know the satellite's position, so I can compute the value of delta T in that case. So the correction for this particular receiver clock for this example is zero point zero zero four microseconds. Once this is known, then you correct the receiver clock and you start producing one pulse per second. Right. So how do we know what is the satellite position? Because satellites are moving all the time. Right? So how do we know correct position of the satellite? Actually, when satellite sends the time signal, it also sends at the same time it sends its position.

Speaker 1 03:36

Okay.

Speaker 2 03:37

And position is sent in two ways. Okay, so orbital parameters.

Speaker 1 03:44

Okay.

Speaker 2 03:45

Again, I'm not a space scientist, so I don't know much about these things, but it looks like it sends you exactly in what Orbit and where it is. Okay, right. So, so it will send you for example, position and, and the gps, you know, time you. And by the way, they use GTC time, okay? Universal time. The satellite clocks, okay, they don't use particular eastern time or they use GTC time. And not only the satellite will send you the position at that location at that time, but remember, it has moved. It also sends you the model, what model it's using for its orbit. So you can calculate, doesn't matter at what time the signal is received. You can calculate the satellite position at that time because your satellite is moving. So it not only sends you the position at that particular time when the signal is sent, it also sends you the modeling of the orbit in which it's moving.

Speaker 2 05:00

And once you know the orbit, you can find out exactly where the satellite is at any time for that matter.

Speaker 1 05:08

Okay?

Speaker 2 05:08

And this orbit situation is updated every two hours.

Speaker 1 05:13

Okay?

Speaker 2 05:14

Every two hours. It doesn't change much. And the only reason it is, you know, updated every two hours because of these perturbations, okay. From the moon or Earth's non uniform gravity or solar radiation, they will slowly affect the orbit. Okay, I didn't know that they write out once the orbit is set, but it seems like orbit is affected by these parameters. Okay, so there are two other type of data that sense is called almanac.

Speaker 1 05:52

Okay.

Speaker 2 05:52

That's basically like a schedule, which satellite is going to be bare at what time because we need minimum four. So the receiver has to pick up which four satellites. So once you know the almanac, then you know where each satellite is and you can pick the right four ones, the closest ones or the most accurate ones. Okay, so those are the type of data that is sent, you know, so I'm going to share this one with you. Okay, so rest is just, you know, almanac is like a train schedule and a map, okay. And the other data live GPS tracking field tells you exactly where a specific train is at what time. Right? So that's the kind of knowledge. Okay, so this is how GPS system works. Very, you know, quick overview, okay. Because many people don't understand that. They just use the receiver, it gets one pulse per second. They don't understand how it really works.

Speaker 2 07:00

Okay, so hopefully this gives you some idea about how this works. So let me go back to our presentation here.

Speaker 3 07:23

It.

Speaker 2 08:00

This is AV one. So now you understand how the receiver works and how do we get one pulse per second. And I already talked about this. So this is the situation of PMU in a substation, okay, which is you know what we have been talking about. You get the voltage signal from the potential transformer and the current signal. You get the current, right, and the voltage signal and it comes to the phasor measurement unit. And this is your clock, okay? This is the clock, one receiver, one clock, which will give you one pulse per second to the pmu. And then what PMU does is PMU will divide that one pulse per second into whatever sampling rate you want to use, okay? So now every PMU have this one pulse per second, okay? So let me just show you. This is the time there is one pulse, okay? After one second there is the second pulse. After one second you will get the third pulse.

Speaker 2 09:11

So PMU will have its own clock which it will synchronize to this pulse and then it will divide this into whatever is the sampling rate.

Speaker 1 09:24

Okay?

Speaker 2 09:24

Let's say you are using seven hundred twenty samples per second. So you will divide this into seven hundred twenty parts and this becomes your sampling pulse. You know, remember we talked about in the hardware. So this becomes your sampling pulse and it will always keep synchronizing to this pulse, okay? Repeatedly it will synchronize to this pulse, okay? So this is how you know the phases, then remain synchronized. It doesn't matter where you are in the world because you are always getting this one pulse per second from the receiver which is obviously synchronized to the GPS signals. And this is the block diagram, okay, which is little bit more detailed. So you get the GPS receiver signal. And then what I meant was, you know, one pulse per second. When you synchronize, that means you use a phase lock loop, okay, to log to that pulse, okay?

Speaker 2 10:35

And then it will produce whatever sampling rate you want which will go to your A to B converter, okay, which will sample and then provide you the signals sampled values and you use them to calculate your phasors. And then you communicate those two phasor data concentrated, okay? And we will talk about the communication part also, how they are communicated. And that's where the standard standard has two parts. One is the measurement. It specifies how good your measurement has to be. The second part is, it specifies how once you have computed the phases here, how you will communicate, okay? It defines the complete message that need to be sent. Okay? So estimation, I'm not going to spend much time because we know how to estimate the phases. The only difference was now you are synchronized, your data is synchronized. So there are DFT based algorithms.

Speaker 2 11:38

There are, you know, least error square algorithms. And you know, we will use a fixed sampling rate. This is Important. That is important. So that means, remember when we talked about that if the frequency changes, you can change the sampling rate so that you always have one cycle of data, right. For DFT will not happen in this case. You have to use the fixed sampling rate because one pulse per second has to be divided into equal numbers. Usually they will use. Now if possible, if you do some tricks, it's possible to change this every time, but still remain synchronized to one pulse per second, right? It's possible to do that, but usually they will use that. So again, I'm going to skip this part. We know how to do this, this. So as I mentioned, you are going to compute the three phasors. And in some applications they only require positive sequence calculation.

Speaker 2 12:57

They don't require, you know, each of these phases separately. A, B, C, you know what is positive sequence, right. So they will only submit positive sequence. And then they will find the derivative of phase angle, which obviously will give you the frequency.

Speaker 1 13:14

Okay.

Speaker 2 13:15

And then the rate of change of frequency, derivative of the frequency. We know how to compute that. And then this is the data that will be submitted.

Speaker 1 13:27

Okay.

Speaker 2 13:28

So single phase phasors, you know, again, depending on the need, you will have a positive sequence phasor, you will have frequency and you will have rate of change of frequency. And this is according to this standard, IEEE C thirty seven point one eight, which is the region of the original standard came in two thousand five.

Speaker 1 13:51

Okay.

Speaker 2 13:51

Because two thousand three blackout happened. And then obviously lot of emphasis was that we should do synchro phases. And then the standard was developed, original one two thousand five and then later on it was revised in twenty eleven.

Speaker 1 14:07

Okay.

Speaker 2 14:08

And by the way, you guys have access to all these standards through the, through the library IEEE Explorer. Okay, if any of you are interested, you can read that. And we will be talking about couple more standards next week also. Okay, so what is the difference between. I have been already mentioning that in regular relays the phasor does not need to be very, very accurate. Whereas here in synchro phases it has to be accurate. Because remember, the relays or normal ieds are basically looking at finding a fault, whereas here we are looking at measurements. Okay, but fast measurements. Okay, so. But less faster than this. Here we need faster measurement. Accuracy is not important. Here the accuracy is important, but speed is not that important for us. That's the difference between the two. I'm going to again skip this one. We already know how to compute things, right?

Speaker 2 15:32

Yeah. So there is another way. How do they characterize the accuracy of phasor okay, we looked at, we can measure the magnitude and angle. Okay, so this is how they characterize the phasor accuracy, and it's called total vector error. So it's nothing but xrn, which is the calculated value of the real part of the phasor, minus xr, which is the original value. Actual value square plus xi is the imaginary part that you calculated minus the original value squared divided by xr squared plus XI squared times one hundred percent. So this is how they characterize the total vector error in a phaser. The standard actually specifies this value. So anytime you want to see how accurate your measurements are or how accurate your method of measurements are, is you always use the total vector, which is specified like this. And this is just the timeline of the standard.

Speaker 1 16:55

Okay.

Speaker 2 16:56

There is another amendment in twenty fourteen.

Speaker 1 17:00

Okay.

Speaker 2 17:08

So let's talk, you know, a little bit about the standard itself.

Speaker 1 17:12

Right?

Speaker 2 17:15

So C thirty seven. One hundred and eighteen point one. There are two parts, as I said. One specifies the measurement. The other one specifies the communication part because you have to measure those phasors and then communicate, send it to the phasor data concentrator.

Speaker 1 17:34

Okay?

Speaker 2 17:35

So accuracy requirements as well as the communication requirements. Okay, so it defines the method for exchange of synchro phases. That's the communication part, okay. In which it specifies the message types, the contents and the data formats. Okay, so that everyone uses the same method of communicating the phasors. Okay, so there is a time tag of synchro phasors. So anytime you calculate the synchro phasor, you have to time tag it. Okay, so what does time tag contain? It contains second of century count.

Speaker 1 18:19

Okay.

Speaker 2 18:19

Fraction of second count even further, and the time quality.

Speaker 1 18:25

Okay?

Speaker 2 18:25

Those are the three parameters. And second of century count is basically a thirty two bit unsigned integer. And it starts from january first, nineteen seventy. Okay, so from january first, nineteen seventy, where you are now, okay, in terms of seconds, thirty two bit unsigned integer.

Speaker 1 18:52

Okay?

Speaker 2 18:52

I'm not sure what they will do once they run out of space, because eventually they will. So they might have to, you know, update this thing. Okay, and then the fraction of the second. Because remember, we are talking about, you know, accuracy up to one microsecondition. So you know, you got the second and then the fraction of the second.

Speaker 1 19:17

Okay? Okay.

Speaker 2 19:20

And then there is the time base. Okay? Fraction of the second you can specify in terms of multiples of, you know, thousand, ten thousand and so on. And that's the time base.

Speaker 1 19:31

Okay?

Speaker 2 19:32

So time is nothing but second of century, then plus fraction divided by the time base If I multiply, if I multiply the fraction by say ten to the power six, right? So and specify this in microseconds, then obviously I have to divide by ten to the power six to get the actual time, right? So this is the time tag of syncopages, okay? And then there is the time quality, quality of the time being indicated. And that's to take care of the leap seconds status. Remember, GPS clocks do not take care of the leap seconds. So you have to take care of that at the receiver clock and that's where the time quality comes. So it's a eight bit unsigned integer, okay? So zero to three bits are, you know, I'll show you a table in that from the standard, okay? Four says leave second pending, okay? And then five is the leave second occurred, six is leave second reaction zero or one, right?

Speaker 2 20:52

You will add that and then seven is left empty. Basically those are the bits for time quality. So the time tag, as I said, is made up of these three parts.

Speaker 1 21:09

Right?

Speaker 2 21:10

So this is the table four, four bit message, right, of time quality, right? So you know how accurate, worst case accuracy within so many seconds of upc within so many seconds. So every receiver clock will tell you, depending on the quality of the clock, they have to indicate what is the quality of time that you are specifying as per the standard. So every PMU manufacturer have to specify that, and that really depends on how good their clock is. Then there are how often do you report, how often do you compute the phasors and how often do you report them?

Speaker 1 21:59

Okay?

Speaker 2 22:01

And the standard says it should be user selectable. But for sixty hertz system, for example, you can, you know, put ten frames, twelve frames, fifteen, twenty, thirty or sixty. Okay, sixty frame means every second you're sending the data, right? So you can select, once you set up your phasor measurement unit and it will then send the data, you know, one frame of data which will include the information, the time tag and so on, right? For fifty hertz it's only three values. They have ten, twenty five. And so those are the reporting rates that they have. For a reporting rate of n frames per second, reporting time will be evenly spaced through each second and the first frame will coincide with the UTC second. So that means if you are sending within one second, if you are sending twenty values, okay? You have to start from the beginning, okay? And then divide it twenty five times, okay?

Speaker 2 23:18

That's basically, you can't just say I'm going to send twenty five values, you know, here, here, here and here, arbitrarily you can't choose. You have to basically, you know, so and then you number the frames. First frame will be number zero all the way to n minus one, right? So standard actually specifies, you know, and this is an example. This is actually an example of. This is again from the standard, you know, they have given an example if you are sending ten frames per second, right? If the frequency is, you know, exactly sixty hertz, okay, Frame number zero.

Speaker 1 24:07

Okay?

Speaker 2 24:08

Will have synchro phaser zero degrees, okay? If it is zero degree, if it is minus ninety sine and cosine, basically right. And then second one will also have zero degrees, zero degrees and so on. But if the frequency does change to say fifty, sixty one hertz, then you start with zero, the next angle will become thirty six degrees.

Speaker 1 24:36

Okay?

Speaker 2 24:37

Because the rotation is happening now at a different rate. It's faster, right, at sixty one. So that again, you know, your PHASOR calculation will automatically take care. That's just, just an example that's given. Okay, what about the latency? Reporting latency? It's as we know, it's the data when it's received, reporting latency, maximum time interval between data report rate as indicated by the data timestamp and the time when data becomes available at the PMU output. So PMU itself will have latency, right? Because it has to do the calculation, there are delays, you have filters and so on.

Speaker 1 25:28

Okay, right.

Speaker 2 25:30

So that is the reporting latency and you have to take care of that.

Speaker 1 25:35

Okay.

Speaker 2 25:36

There are two types of PMQ classes. One is the protection class, okay? Which as we saw for that you need not to be very, very accurate, but you have to be fast.

Speaker 1 25:49

Okay?

Speaker 2 25:49

Measurement class is the one where you need to be accurate, but doesn't have to be extremely fast. So for fast response applications they use P class. For other applications they use M class. And obviously the users are going to.

Speaker 4 26:10

Select.

Speaker 2 26:12

You know, depending on their need, you know, what type of PMG they need. If they are using it for protection application, then obviously they have to use the P class. If you are using for more measurement applications, then they can use the M class.

Speaker 1 26:30

Okay?

Speaker 2 26:31

And the manufacturers have to actually designate each of their PMU with a P class or amp loss. So this is again, you know, define the small signal oscillation using positive sequence, okay. Time domain signal. And you know, kind of tells you what the data will look like. Okay, so this is one application positive sequence time domain signal. And these are the small scale, small signal oscillations. Again, the phasor has a, you know, oscillation Limit, okay. It doesn't stay constant. It may be something like, you know, something like this, like that, right? So those are, you know, characterization of. And this is just different type of application. There is a frequency ramp when the frequency changes over time.

Speaker 1 27:52

Okay.

Speaker 2 27:53

So Pl r F t square rf is the ramp rate. Right. And then the frequency also can change, you know, dynamically. Right? It doesn't have to be in a data only.

Speaker 1 28:13

Okay.

Speaker 2 28:13

Now the standard also specifies what should be the performance of PMG under all these conditions. You know, when there is a dynamic oscillation, when there is a frequency change. Okay, but should it, you know what should be the TBE we talked about the total vector add up. So if the signal frequency changes, okay, between plus minus two hertz, the maximum total vector error that your PMU should have is one percent.

Speaker 1 28:53

Okay?

Speaker 2 28:54

That's the maximum tv. And obviously when you know, they will put a stamp on a PMU that it meets this standard, it has to meet this performance level. This is for P class. And for M class it's even more strict. For M class, the frequency can change plus minus two hertz if the frequency is less than ten hertz. It should change plus minus FS by five if the frequency is between ten to twenty five. Or it can plus minus five hertz if the frequency is greater than twenty five. And the error should stay one percent. So that's the requirement. Similarly, the voltage magnitude, if the magnitude, if it is one hundred percent rated and the magnitude is between eighty to one hundred twenty percent of the rated value, the error should stay within one percent of tpe. So those are again the standard requirements. This is for the P class. For M class, again it's much more strict.

Speaker 2 30:05

The magnitude can be ten to one hundred and twenty percent.

Speaker 1 30:10

Okay?

Speaker 2 30:10

And the error should stay one percent tbd. Similarly for the crud, okay, ten to two hundred percent and ten to two hundred percent. So those are again performance requirements. So this will define what type of algorithms you can use in your. And it's much stricter than, you know, than what we used in the relays. So obviously you have to see what algorithms will perform under these conditions. And this is why we had proposed that iterative method which actually the later on we did some work once the standard was out to show that that particular algorithm meets the standard requirements. Again, if you are interested, that paper is available on IEEE Explore also. And then in presence of harmonics, that's another requirement, right? So if harmonic distortion is less than zero point two percent, okay, then one percent each harmonic up to fiftieth all the way up to fiftieth harmonic, TBE should be one percent.

Speaker 1 31:36

Okay.

Speaker 2 31:36

For the protection class, ten percent of each harmonic up to fiftieth, so you have your original signal, let's say it's one one volt or ten volt each harmonic, ten percent of that up to twentieth, you should be able to have a TBE of one percent maximum.

Speaker 1 31:58

Okay.

Speaker 2 31:58

And similarly out of band interference, not harmonics, but non harmonics.

Speaker 1 32:03

Okay.

Speaker 2 32:04

So it has a requirement for that. Also small signal oscillations, again, same way it has that those requirements, okay, so if the you know your frequency is modulated, right, you have a small signal oscillation with your signal, then it should have three percent maximum tb. Okay, so those are again the requirements. If the frequency changes by plus minus one hertz per second, okay, you have an error in P class one percent M cross also one percent and the frequency range is plus minus two Here it's even more stricter within that range, if your frequency is changing by plus minus one hertz per second, you should be able to accommodate that. And this is the reporting latency, how much time you can take to do all these calculations. For the P class it's two yfs, which means you can take two sampling intervals.

Speaker 1 33:15

That's it.

Speaker 2 33:16

Whereas for the M class you can take up to five sampling intervals to do all your calculations. And this is why you know, these pfu's skip. You know, they will do calculations at this instant, then take time and then at the fifth sampling interval they will do another calculation, but they will still use all the data. Okay, the calculations are not done all the time. So those are again the requirements in terms of latency, how much time basically you will take. Okay, so this is the message format we talked about, the time tag.

Speaker 1 33:58

Okay.

Speaker 2 33:59

There are four types of messages that are defined. Data which is sent by pmu, configuration header and command. So obviously when you start, you have to give the configuration, okay, you have to send the header and then the data. So IEEE standard defines all these. So data message obviously has to contain phasors, either in rectangular or polar form. You will have that status of breakers and status of switches. So this is the data that it sends. So it basically defines configuration message is machine readable, how many phases you are sending. Because one phaser measurement unit can have, you know, say three voltages, three crumbs, right? So it's going to send all that data in one frame. So it has to specify that in the configuration message. So what is expected substation Name and the rate of data transmission. Are you sending ten frames per second or fifty frames per second?

Speaker 2 35:08

Right. So that has to be defined. And the hydro message is basically information about the pmu.

Speaker 1 35:17

Okay.

Speaker 2 35:17

What is the name of the pmu, what algorithm, what filtering you are using, and so on. And then the command message indicating the appropriate action to be taken. What action to be taken. So those are all defined in the standard. So this is really configuration and header using the command and these are the command words. Okay. So you can basically say turn off transmission of data frame, turn on transmission of data frames and so on. So it will send those messages. So it basically is telling you what to communicate and how to communicate, how in the sense what the message should look like and what you are communicating. And the first part, as I said, was the performance requirements of the png.

Speaker 1 36:15

Okay.

Speaker 2 36:19

And these are the transmission rates.

Speaker 1 36:22

Okay.

Speaker 2 36:23

If you are sending two phases in all floating point. If you are sending twelve phases, an integer. Right? Right. If you are sending twelve phases, two analog, two digital. So that again depends on the transmission, what you are sending, that will be your transmission. These are different examples of the transmission rates. Okay, you can send over uvp, IP or tcpip.

Speaker 1 36:50

Okay.

Speaker 2 36:51

That's the method we use.

Speaker 1 36:55

Okay.

Speaker 2 36:56

And these are the delays.

Speaker 1 36:59

Okay.

Speaker 2 37:00

So you know, we are familiar with some of these delays. What is the sapling window, how much? You know, if you use one cycle, obviously you will be delayed by one cycle. If you use half cycle, you will be delayed by half cycle. What is the filtering? How much filtering takes how much time? Right. How much time the processing takes? Right. And then communication and so on. So those are again all the delays that happen before the phasor becomes really available at the other end. Right, but that, you know, although the standard specifies what should be the delay, maximum delay, but for the phasor it's okay, because it's time stamped, so it is synchronized. Although it's delayed, it is synchronized. Okay, so let's quickly look at the applications. So we now have an idea of what are synchronized phasor measurements. You know, how they are to be calculated.

Speaker 2 38:08

What are the requirements from the PMU in terms of calculation accuracy and what are the requirements from the standard in terms of communicating to the PHAGER data concentrator, but possible applications, state estimation, that's one. This is the most promising application where you now have positive sequence phases at every bus in the system. At every point in the system. So you know exactly how your system looks like. Okay, so presently they use state estimation using nonlinear methods. So some of the parameters are missing. We estimate them. Okay, which is not very, you know, I should say accurate as well as it's very much time consuming.

Speaker 1 39:02

Okay.

Speaker 2 39:03

So by the time you find out what the state estimation is, you know, system has already moved on. But here, other than the latency, you know exactly in real time, what are the buses, what are the voltages at each bus? Bus, what are the currents flowing in each line? So you know that. Okay, so we don't need iterative techniques. The values are available directly from the phaser measurement. So this is one of the best applications. And then in terms of relaying, they use out of step relaying whether these two generators are going out of step. Okay, let's say disturbance happens and then they, you know, the speeds change. Are they going to go out of step? Okay, so you can actually use the PMQ data and you can estimate. Okay, if they are going to go out of step. If they are going to go out of step, then obviously you need to disconnect. Otherwise you can keep them connected.

Speaker 2 40:12

Okay, so this is another application actually. This has been done in, in the Florida power system, Florida and Georgia, they are both connected with each other and this is where, you know, they were having issues in terms of generators going out of step between the two systems. So they actually put the pmus and they were able to estimate for any disturbance if they are going to go out of step. Obviously there are more details than I'm giving you here. Here. I just want to give you an idea that what applications are possible has been done using synchro phases. Okay, this is similar power swing blocking. Okay, Similar application where, you know, using PMU data from, from various buses, you can actually, when the power swing happens, you can see, you know, you don't trip your distance relays. Okay, Those of you who are familiar with protection will know that.

Speaker 2 41:22

Right? Right. So you can actually block your tripping because of the power supply. So this is another one. And small signal oscillation detection. This has been done actually at many places where, you know, small or large disturbances that are present in the system. Okay, so there are oscillations, small oscillation frequencies, zero point one to two hertz. There was no way of detecting those. But with PMG data now you can do that. Okay, so you know whether your system is properly damped or not, which is related to now the controllers basically. So you can design your controllers accordingly. If a disturbance happens, you want the system to be damped so that you know, you're not, you know where the Oscillations actually grow with time. Okay, so this is related to more control system. Okay, so that's again, these are just few examples of, you know, which pmus have been able to capture.

Speaker 2 42:35

Okay, the small signal oscillation, for example. You see, because of a disturbance, there are small signal oscillations here. They can actually find out exactly the frequency of those zero point two six four and three point four six percent damping. There is another one right here. It became unstable. You know, oscillations are growing. So you could actually determine that using your pmdu. Previously it wasn't possible. Okay, and now then you can design your controllers to capture these so that this doesn't happen. So this is again lot of these applications have happened already in the system. Small signal oscillations. Then there is frequency stability monitoring and trend. You can predict the trend of system frequency, whether it's going to continue decreasing or continue increasing and then take actions accordingly. Right?

Speaker 2 43:45

I'm not aware of this application. And voltage and stability, I am aware, right? That's another area where so obviously, because now we know the voltage at every bus, right? Synchronized value, you can actually do voltage instability prediction whether you're going to go, you know, unstable because of voltage.

Speaker 1 44:11

Okay.

Speaker 2 44:12

So I know in BC hydro system they have done that. Okay, Dynamic line rating. I mean we know the current, right, at every point and how much the transmission line now can be used. You know, if it is underutilized, you can actually put more on. So synchro phaser measurements, they couple them with the local weather situation and do the dynamic line. Right. So we could do that. So what has been the field experience? Although there are some positive, you know, indications like all these applications I mentioned, but there are some problems that have been reported. Okay, so synchro phase are quality issues. And some of it is actually related to the algorithm because they are not using proper algorithms. In this case, some of it is related to the communication issues. Right. And synchro phaser quality issue. So they may not strictly meet the standard or in some cases standard need to be updated also.

Speaker 2 45:29

Okay, so I'm sure in future they are going to update this standard to take care of some of the, you know, based on the field experience to take care of some of these issues. And then we have repeated timestamp that's again all related to the PMG repeated value of magnitude at phase angles. Jump in phase angle, but jump in magnitude is rare. So those are again algorithm related issues. Right? Variation of phase angle within the same substation at the same Bus one PMU is measuring different phase angle, another one is measuring different phase angle at the same time. So you are in the same substation. The voltage at two places has to be exactly same, but they're finding it's different. And missing data is again more communication related issues.

Speaker 1 46:28

Okay.

Speaker 2 46:29

And we will talk about missing data even in when we talk about IEC sixty one eight hundred fifty standard in the substation automation. There are solutions to that.

Speaker 1 46:40

Okay.

Speaker 2 46:41

And then obviously they have not addressed the cybersecurity issue in the standard itself. You know, all this data is flying around and we are using it to monitor and control the system. But there is no cyber security aspects in this standard. It only specifies the performance and it also specifies the communication form. It doesn't specify what to do with cyber security. But there is a different standard that has come. Sixty one, I think it's number is sixty one thousand three hundred and fifty. IEC standard.

Speaker 1 47:20

Okay.

Speaker 2 47:20

And we will briefly talk about that next week. I think I just want to give you a very quick idea about that. And that one is actually becoming important for all these applications. There is one standards that's more for all industrial system, but there is another one that's specifically for power systems.

Speaker 1 47:44

Okay.

Speaker 2 47:45

Data in the substation and these ones also from the PMG to pdc, you know, so that nobody changes the data, nobody can deny that data, you know, all kind of attacks. So it specifies that.

Speaker 1 48:03

Okay.

Speaker 2 48:05

Yeah, I think that's all I have. Hopefully this gives you a very quick idea about the synchro phases. Okay, so do you have any questions on this? I will share this information as well as that you know the five about the gps. How do we get one pulse per second accurately?

Speaker 1 48:31

Okay.

Speaker 2 48:32

What does the receiver do really in that case, I think here we have a GPS antenna in our university and we have receivers actually in the lab where we can do, you know, receive one pulse per second and then depending upon what we are doing, we can use that. Okay, so I'll stop here. Let's say, well eleven fifteen, you can come back and do your work on your assignment. So many of you have already sent me your self evaluation. I think those who haven't, make sure you send it to me. And also we will do the same thing for assignment number three. And everything has to be completed by next Wednesday.

Speaker 1 49:27

Okay.

Speaker 2 49:29

Because your assignment is due on Monday. I'm going to post the solution on Monday, you take a look at it and by next Wednesday you send me everything. All three assignments. I know most of you have done one and two and you do the three the same way, then I'm going to start marking those.

Speaker 1 49:48

Okay?

Speaker 2 49:49

Yeah. And maybe we will have a quiz, one more quiz on some of these aspects.

Speaker 1 49:57

Okay.

Speaker 2 49:58

Because I'm not giving you an assignment on this. So we will probably have a quiz on that because we don't have time for another assignment.

Speaker 1 50:07

Okay.

Speaker 2 50:08

Yeah. All the final examples, exam format, be like final exam. So this is what we will do. I think your last day is sixteenth, right? Sixteenth. We are not going to have a formal lecture. I'm going to give you. We will go over the assignments.

Speaker 1 50:25

Okay.

Speaker 2 50:25

Many of you actually it's interesting. I specifically asked for Rockefeller rooted in algorithm. Many of you somehow did something totally different. They used, you know, eight point. I have no idea where that came from. It was very clear in assignment one that you must do Rockefeller Ruder. Three samples. They used eight samples and sign and cosine. Some of you have done it. I don't know why and how it happened because there was no indication of that in the assignment.

Speaker 1 50:59

Okay.

Speaker 2 51:01

So yeah, so we will go over those assignments. Just if you have any questions and also you will get the final exam, which is take home. Take home. And I want you to just quickly read over it and make sure if you have any immediate questions for me, you know, rather than everyone emailing me later on, it's a good idea, you read and if you have any questions, you ask me at that time. And obviously you can ask later on also. But I'm hoping that most of the questions will be answered there.

Speaker 1 51:35

Okay.

Speaker 2 51:38

Final is take home.

Speaker 5 51:39

Oh yeah.

Speaker 4 51:40

Will that be like the assignments?

Speaker 2 51:43

It will be more than assignment today. Final exam. It's exam.

Speaker 5 51:48

So you have a time limit.

Speaker 2 51:49

Like we will have a time limit. Yeah, obviously sixteen. I'm thinking I will give you like four days. That's my initial thinking.

Speaker 5 52:01

What's the deadline for that self evaluation?

Speaker 2 52:04

Self evaluation is by next Wednesday, eleventh. Yeah. Okay. All three of them. All three assignments.

Speaker 1 52:14

Okay.

Speaker 2 52:17

Okay. So let's have few minutes of break and then eleven fifteen you can start. And make sure you submit by twelve fifteen because some of you have said, oh, I missed the time. You know, you submit and you can, whatever is left, you can take home and do it.

Speaker 5 53:59

But you are taller than me. So you, I mean you small with the long dress. For me, mine is like all the knee length. So yeah, it looks very bomb.

Speaker 6 54:36

Yeah.

Speaker 5 54:39

Don'T worry, you got this. You already got one and two, right? Two a bit easier.

Speaker 3 56:38

It's so many.

Speaker 5 57:15

Nothing, Nothing. Right, let's do it fast.

Speaker 6 58:02

One day, right? Four days.

Speaker 5 58:06

Yeah.

Speaker 6 58:06

Wow.

Speaker 5 58:07

He said that?

Speaker 6 58:10

Yeah. But we don't have four days, right? Because four days later we will have ssd.

Speaker 5 58:21

Yeah. So. So like why that.

Speaker 4 01:01:01

Jam?

Speaker 3 01:01:19

It's it, it's, it's, it's it, it's, it's, it's, it's, it's, it's, it's, it's.

Speaker 5 01:34:33

Yeah.

Speaker 3 01:38:46

It'S it's, it's, it's, it's it.

Speaker 5 01:59:37

Yeah. Compliment. That's a lot. Thank you. Most of the thanks to you.

Speaker 4 01:59:47

How are we supposed to do that in one hour?

Speaker 5 01:59:49

Yeah, a lot of people cannot get in.

Speaker 6 01:59:55

That's why professor said for the assignment one. How did you get so much example.

Speaker 5 02:00:04

Why A lot of people can. Hello. How hard is it?

Speaker 4 02:00:18

So difficult.

Speaker 5 02:00:19

So many. Right. Cannot finish you. One hour.

Speaker 4 02:00:21

How many figure did you. Yeah, crazy.

Speaker 2 02:00:26

Did you finish it?

Speaker 5 02:00:28

Almost by. They need a few to.

Speaker 4 02:00:31

We still have to see if it's right.

Speaker 5 02:00:36

Okay. Already have the format. Still not enough for question two.

Speaker 4 02:00:46

I. Because it didn't say. Question three says one hundred eighty hertz, right?

Speaker 5 02:00:50

Yeah.

Speaker 4 02:00:50

Question two doesn't say hertz, it just says filter. So I asked him, is it only sixteen hertz? Cuz that's what we did, right? He said no, I want all the filters.

Speaker 5 02:00:58

Oh, okay.

Speaker 4 02:00:59

So if you're doing all the filters, why is he asking question three? It already covers one hundred eighty.

Speaker 5 02:01:03

Yeah.

Speaker 4 02:01:04

So for question one, I did sixty, I did DC and I said look at question three for one hundred eighty. So that's what I was trying to explain to you guys. But then I didn't want to confuse you.

Speaker 2 02:01:12

Right?

Speaker 6 02:01:12

No, I, I didn't get.

Speaker 5 02:01:14

I got it. I got it. So one hundred eighty. I just put the.

Speaker 6 02:01:18

I was.

Speaker 5 02:01:19

We are imaginary.

Speaker 6 02:01:20

I know. I. I have the question for the, for the, for the, the assignment. But yeah, I asked. But I forgot the question.

Speaker 4 02:01:28

No. You know how we have the matrix? It has three filters in it, right?

Speaker 6 02:01:33

One is.

Speaker 4 02:01:33

The first one is one hundred eighty and one is for dc. He said I want it for question two. Two. He wants to see all.

Speaker 5 02:01:43

Oh, oh, yes.

Speaker 4 02:01:44

But I. Why question three? Ask one hundred and eighty.

Speaker 2 02:01:47

Right?

Speaker 5 02:01:47

Yeah. So same thing.

Speaker 4 02:01:49

So what I did was I did the sixty like we all did. I said look at question three for one hundred eighty. Cuz we're just repeating.

Speaker 2 02:01:55

Right?

Speaker 4 02:01:55

And then I added the dc. That's what he said. All three.

Speaker 5 02:02:02

All three.

Speaker 6 02:02:03

That's why fundamental and how many.

Speaker 4 02:02:06

That's why.

Speaker 2 02:02:06

I don't know whether he's just.

Speaker 5 02:02:08

So I. I did That I did that like I don't know he did three no no. For one hundred ninety eight I only captured the command that. Yeah, we are imaginary, right?

Speaker 6 02:02:20

No, I didn't comment but it's fine. So for the home part maybe we can.

Speaker 4 02:02:27

We should wait until Monday wait for him to post the solution so then we can just do it after he posts, right?

Speaker 6 02:02:32

Why do you want to. Yeah yeah he will post a solution.

Speaker 5 02:02:38

Okay missed out but today need are almost all right I hope it's correct your party also good explain it the yeah explain well that I took from.

Speaker 4 02:02:50

The class he said either the sample size increase is good or if you add more filters because the least error squared gets more data points oh I.

Speaker 5 02:02:59

I asked chatgpt also same thing as you said that the increase is very. You are the professor.

Speaker 4 02:03:09

I. I was talking to my friend who same subject as us but he took the space one he says it's amazing.

Speaker 5 02:03:18

Space is amazing.

Speaker 6 02:03:19

It's good, right? Yeah, maybe yeah we cannot choose right because it's a compl.

Speaker 4 02:03:26

We would have to do the ad drop. He did the ad drop cuz he's in our program Program?

Speaker 6 02:03:33

But that's the base one is our program.

Speaker 4 02:03:36

No, but. So we have to do the.

Speaker 6 02:03:38

Oh, this is a magn.

Speaker 4 02:03:42

But he says the. He's in our program and he said.

Speaker 5 02:03:45

He likes it but more job, you know Mo didn't like it.

Speaker 4 02:03:50

Yeah, he didn't like it. He got intimidated but if he likes it then it's probably an easy course because last semester he wasn't keeping up.

Speaker 5 02:03:58

With courses and stuff But I don't.

Speaker 6 02:04:00

Want to waste your choice on the mechanical program. I wonder.

Speaker 4 02:04:04

Yeah now. Now there's no point but if. If we. It doesn't matter now I wonder.

Speaker 6 02:04:09

Yeah because we. We only have two courses from other program I wonder do from software program.

Speaker 2 02:04:16

Oh my God.

Speaker 6 02:04:20

I need a.

Speaker 3 02:04:21

It.

Speaker 5 02:04:52

Hope we did it correctly.

Speaker 2 02:05:12

It.

Speaker 6 02:05:42

Did you get any response from professor after submitting the email?

Speaker 5 02:05:48

You talking to me, Maggie? Yeah, after what I was sending the.

Speaker 6 02:05:53

Email to Professor Uhhuh. Did you get any response?

Speaker 5 02:05:57

No.

Speaker 6 02:06:00

You did front time address?

Speaker 5 02:06:05

I did. I did what.

Speaker 3 02:06:29

Sam.

Speaker 2 02:07:44

She was up.

Speaker 4 02:07:44

To like two doing this you too much.

Speaker 6 02:07:46

I was too.

Speaker 4 02:07:49

I was. I was sleeping is what she was asking there.

Speaker 3 02:07:52

Oh yeah.

Speaker 6 02:07:53

I work over two thirty I travel too. But I did nothing right. I do everything but. Yeah, but it's fine, I understand it.

Speaker 4 02:08:02

You understand it well you would have been correct but he. He puts things around his electronic. I follow the lecture. She did it same way but she like cuz I did the head. I wrote the head calculations right. She did the same thing calculation stuff. So that my.

Speaker 5 02:08:55

I do. I did after that I posted to chat GBG and asked me to transfer to the. The tap in. Oh yeah those I a bit different. I do. I did a part. Really? You did a part? Yeah.

Speaker 4 02:09:23

Can't wait to be done this course now I have to out figure figure out the recursive algorithm. It's literally. It's hurting my head. But I think he'll ask that for the final. I'm kind of scared for the final he's giving us forty eight.

Speaker 5 02:09:43

But then final is open book, right? In a way.

Speaker 4 02:09:47

Yeah. That's. That's the worst thing you can do.

Speaker 6 02:09:49

Open book doesn't work right.

Speaker 5 02:09:51

Even open book means counter.

Speaker 4 02:09:54

You're not going to find the answers. Yeah. So if this is one hour and then four days is like it's probably not too bad.

Speaker 6 02:10:08

He may. He doesn't want to everybody pass the course so he.

Speaker 2 02:10:15

Yeah.

Speaker 4 02:10:15

But then why did he make this assignment? Yeah.

Speaker 5 02:10:21

I already give you hint last night if somebody catch it.

Speaker 4 02:10:25

I think that was a mistake.

Speaker 5 02:10:27

Yeah. Yeah yeah. Actually not supposed to but he thought nobody was see around twelve plus already. Who. Who gonna go and check for the assignments or only that Genius.

Speaker 4 02:10:40

Yeah. I don't know. I was going to the washroom. I was like I.

Speaker 6 02:10:50

Oh thank you so much.

Speaker 4 02:11:07

Are you staying get a message?

Speaker 5 02:11:17

At first we thought of taking some photos with the event but Blue Ch is end so.

Speaker 4 02:11:26

This.

Speaker 5 02:11:27

It's graduation convocation ceremony. People are graduating.

Speaker 4 02:12:00

We finish in fall.

Speaker 6 02:12:01

Yeah, but I mean for the even.

Speaker 4 02:12:04

Yeah. Winter also.

Speaker 5 02:12:05

But winter I thought even is one year, one time.

Speaker 6 02:12:09

How.

Speaker 4 02:12:09

How many times Convocation is every time you graduate.

Speaker 6 02:12:15

No. Oh yeah But I. I didn't see any from the winter might be indoors after. After the fourth semester because I studied here for the erc. Right. I didn't see any winter might be.

Speaker 4 02:12:27

Endorsed because our convocation was indoors. It was held in the gym.

Speaker 5 02:12:32

Oh I see.

Speaker 6 02:12:33

But we can now wear beautiful dress.

Speaker 5 02:12:39

Yeah. It's so. So cool. Yeah. He already. He already experienced once.

Speaker 2 02:12:47

Yeah.

Speaker 5 02:12:48

The same right onto your deck also right. Your undergrad was here, right?

Speaker 4 02:12:52

Yeah.

Speaker 5 02:12:54

How is it? Is it amazing Convocation?

Speaker 6 02:12:58

I also did. I also did it one time from another career. Right. Justin, did you sing the Cat Oh Canada this song?

Speaker 4 02:13:12

I don't think so. I don't think we have.

Speaker 5 02:13:14

Yes.

Speaker 6 02:13:14

At the center college.

Speaker 5 02:13:17

Oh Canada.

Speaker 6 02:13:18

Yeah. Oh Canada.

Speaker 4 02:13:19

In high school and middle school we had to sing it every Day every morning. Yeah.

Speaker 5 02:13:27

You know how to sing? I want to learn also.

Speaker 6 02:13:32

Isn't that bad?

Speaker 5 02:13:35

You have a YouTube. The song no Canada.

Speaker 4 02:13:39

Just type in no Canada.

Speaker 5 02:13:41

Is it YouTube? I want to learn.

Speaker 6 02:13:49

Okay. We should work for the project. Yeah. Oh, did you check the file if the TA upload anything?

Speaker 5 02:14:01

No, I don't see anything yet. Did you see?

Speaker 6 02:14:08

We don't have template. How do you.

Speaker 5 02:14:10

I think it's a. No need. It just is your old template. I think so. He said you can use any template, right? From the overlay.

Speaker 6 02:14:19

Yeah, but I didn't listen to him. So I don't know.

Speaker 4 02:14:24

But templates can be easily.

Speaker 6 02:14:27

Yeah, it's. I'm not talking about the format template. Yeah, because he introduced something. The first paragraph. You should do the. Introduce how to do content. Yeah, the how to. The second part should be something. But I didn't focus on him. It's boring image to him.

Speaker 5 02:14:47

He didn't reply.

Speaker 6 02:14:48

I mean he always. He didn't reply. Yeah. But tomorrow we have class, right? We should ask the professor. We only have two days. When will you give us the template?

Speaker 3 02:15:05

Yeah.

Speaker 5 02:15:05

Really?

Speaker 4 02:15:13

You guys seen the Mission Mission Impossible? Are you guys seeing the Mission Impossible?

Speaker 5 02:15:20

Oh no, not how is it? Have you. Yeah, it's good to the new one.

Speaker 4 02:15:24

You sure?

Speaker 5 02:15:25

Why the new one? Right. The latest one.

Speaker 4 02:15:27

I. I'm going tomorrow with my undergrad friends. There are like ten of them.

Speaker 5 02:15:32

They decided to go to watch in the Twitter.

Speaker 4 02:15:37

Yeah, I think we're gonna go for imx, right?

Speaker 5 02:15:41

Have fun guys. But I heard that it's a lot actually people doesn't wanna go.

Speaker 4 02:15:50

Have you watched the Mission Impossible movies?

Speaker 5 02:15:52

I did with Tom Cruz. My husband was Tom Cruise is a American actor for his famous movie is Mission Impossible. Am I. Am I one, two, three. Now it's four, right? Four or six? Five. Five. Yeah. My husband is crazy, but not mi. So he watched every in movie theater also we watch over and over again.

Speaker 6 02:16:23

Marvel.

Speaker 5 02:16:24

No, it's Mi is individual movie. But now they have like Chinese. My social title means movie means.

Speaker 4 02:16:46

It'S like an action.

Speaker 2 02:16:47

Action.

Speaker 5 02:16:55

It's not another Marvel series. This is. It's not Marvel. It's a break Impossible. There final recording. Right? The last one. Yeah. Mission Impossible.

Speaker 6 02:17:12

Oh yeah.

Speaker 5 02:17:14

You know, I watch this series because it's very famous.

Speaker 6 02:17:20

Eight. The eight. Right. The last one. The previous one. Ten.

Speaker 5 02:17:27

No, now it's five.

Speaker 4 02:17:28

Only four.

Speaker 5 02:17:29

Four. Five. Four. Four. But it didn't say four. Right, but supposed to be four. Yeah.

Speaker 6 02:17:37

Okay.

Speaker 4 02:17:38

I'm not like a huge fan or anything.

Speaker 5 02:17:39

No, no. It's a time my husband was maybe after but it's not as. As. Don't put so high expectation on it.

Speaker 4 02:17:52

No, I don't. I'm only going because my undergrad I.

Speaker 5 02:17:55

Thought a lot as want to already pushing me.

Speaker 4 02:18:10

You have very little time pushing me.

Speaker 5 02:18:17

Okay, okay, let's go. Let's go. I went, I went. You know, I do my part always.

Speaker 6 02:18:22

I hold the lady. The lady.

Speaker 5 02:18:26

She probably will be late. Although I will be happy. Deal.

Speaker 6 02:18:31

He isn't happy.

Speaker 5 02:18:34

I know you're going be like.

Speaker 2 02:18:34

I don't.

Speaker 5 02:18:38

Don'T. Don't fight with. Okay. She was I the other day we almost fight with her. Don't fight.

Speaker 4 02:18:45

So the professor said he got everyone got eight points and did the same thing. So I think like one person did it and then all of them copy.

Speaker 5 02:18:53

I think so.

Speaker 4 02:18:56

Cuz everyone got the same same wrong.

Speaker 5 02:18:59

So why so many? I don't know why you get it wrong. I asked for the three samples. You don't even do the.

Speaker 6 02:19:08

How did you get the file right?

Speaker 5 02:19:10

You don't even do the algorithm correct. Right. It's Rohan for example, I think he.

Speaker 4 02:19:15

Said he gave us fifteen samples, right? They. They. They only had like eight and they all had the same answer.

Speaker 5 02:19:22

So they didn't even get the algorithm right. Yeah, didn't do the voice of the algorithm.

Speaker 4 02:19:31

Rockefeller.

Speaker 5 02:19:32

Rockefeller. Yeah. I didn't even do that. Okay.

Speaker 6 02:19:38

Anyway, I wanna graduate right now. Right now. The OIMP invited the four foreign workers and the international students and also the in demand skills program. But not. But without the master stream.

Speaker 5 02:20:01

No Master stream. Master stream. But can we go into that stream? No.

Speaker 6 02:20:09

If you have the job offer and the company would like to sponsor you, it's a fine for me.

Speaker 5 02:20:19

You are over qualified. We are talking about PR stream.

Speaker 6 02:20:24

It's a hard. It's a hard because. Yeah. It's not only the job offer. The company should have many people with PR or citizen also they earn the modern one hundred million.

Speaker 5 02:20:43

Not easy to get it right. For us, PR is really a barrier after graduation it's hard to get now you don't get br that hard, right? Yeah.

Speaker 6 02:21:01

The numbers was decreased half half fifty percent.

Speaker 5 02:21:06

Yeah, yeah fifty percent yesterday and now side.

Speaker 6 02:21:09

Yeah.

Speaker 5 02:21:09

Yeah. Especially Ontario.

Speaker 6 02:21:13

No, for every province.

Speaker 5 02:21:15

No, that's just a days.

Speaker 6 02:21:17

Oh yeah.

Speaker 5 02:21:18

Ontario say that they are in. Yeah.

Speaker 6 02:21:25

If you want to do something, do it earlier.

Speaker 5 02:21:29

Do a blind job.

Speaker 6 02:21:31

So everything.

Speaker 5 02:21:37

Hopefully after we graduate things are changing and we got it better. At least you can be hopeful. Hey, I don't hold you back. But I don't. Yeah, but I don't hold you back. Your friends waiting. Right.

Speaker 6 02:21:58

Okay.

Speaker 5 02:21:59

Somehow you hang out. Yeah.

Speaker 4 02:22:02

Yeah.

Speaker 5 02:22:02

As you promise.

Speaker 4 02:22:05

Yeah.

Speaker 5 02:22:06

Okay, let's go.

Speaker 4 02:22:08

Okay.

Speaker 5 02:22:09

Bye.

Speaker 6 02:22:10

Bye.

Speaker 5 02:22:11

You're going this way?

Speaker 6 02:22:12

Yeah, this way. You want to go together? Let me see.

Speaker 5 02:22:16

Two. It's okay. No, I. I said thinking of going the other side of Founders gate. Just got two car, two bus and here only two or two.

Speaker 1 02:22:28

Okay.

Speaker 2 02:22:40

We have two more weeks.

Speaker 4 02:22:41

We have only one week left.

Speaker 5 02:22:43

It takes time to recover.

Speaker 2 02:22:45

Right?

Speaker 4 02:22:48

But I. I've been exercising every day.

Speaker 5 02:22:51

Did you go to gym? I thought you went to the exercise gym.

Speaker 4 02:22:55

Yeah, but it's closed. Better. So I walk around this entire close. I come really early, right.

Speaker 5 02:23:02

I come at like it's open a right?

Speaker 4 02:23:09

Yeah. When I come by six thirty. So the night before walk around campus.

Speaker 5 02:23:15

Oh yeah.

Speaker 4 02:23:16

Walk around campus. I get tuckered out by around eight.

Speaker 5 02:23:24

Maybe somehow we will go for bam bam. I asked my husband to bring my baming.

Speaker 6 02:23:30

Yeah but it was always.

Speaker 4 02:23:35

We can just do it outside.

Speaker 5 02:23:40

You need to be in close apartment. Okay. Okay, let's see how many guys you will have your after class.

Speaker 4 02:24:41

What did you do? Yeah, but I said don't take any doors.

Speaker 5 02:24:58

Yeah.

Speaker 4 02:24:58

So let's see what happens but okay, but you know, theoretically it's straight. I'm not going to give you like every little.

Speaker 5 02:25:10

Oh yeah, don't be any. Don't.

Speaker 4 02:25:13

I think I see what you mean. I could have said that. Don't take it me doors. Right?

Speaker 6 02:25:23

Yes. I don't know how should I go if I. If I don't take.

Speaker 4 02:25:28

Well, there's only one place with no.

Speaker 5 02:25:30

Doors you shouldn't walk about the co do.

Speaker 4 02:25:33

The only option is straight otherwise you go in circles around that Hillary door. No, you're right, I was wrong.

Speaker 5 02:25:42

No, no, it's a different way.

Speaker 4 02:26:13

Sam.

Speaker 5 02:26:42

Oh yeah. Don't say any dogs. Remember now.

Speaker 6 02:27:06

For my.

Speaker 5 02:27:06

For my kids I have to.

Speaker 6 02:27:08

I have to go this way.

Speaker 4 02:27:10

Yeah, you usually go there right.

Speaker 5 02:27:24

After I find the research I finally your kind have to correct adding anything so.

Speaker 6 02:27:31

Yeah, you also do the.

Speaker 5 02:27:36

But first first I need to get my own data, right? Yeah yeah. All the research Then I will let you do the policy part. Yeah. Correcting for me not polishing. Correcting. Yeah see she saw my boss, you know like who should be one or.

Speaker 4 02:27:56

Another I was working with their last semester right.

Speaker 5 02:28:01

The other two you p me. I'm always do my part. Okay, I know, I know. I'm just kidding.

Speaker 6 02:28:11

Right. So you can get okay, Okay.

Speaker 5 02:28:15

I want. I want. Don't worry. I do my part. Okay.

Speaker 4 02:28:19

Yeah. I'm going to start charging.

Speaker 5 02:28:21

Okay, well, how much do you want? Chocolate.

Speaker 4 02:28:24

How much do professors make? Two hundred thousand.

Speaker 5 02:28:28

You can be TA only. Come on. You don't have certificate. So TA will be bachelor. No, no, no.

Speaker 6 02:28:35

We will apply for from the graduation office. Right?

Speaker 5 02:28:41

Apply for T. I have to do PhD. You have to do PhD.

Speaker 4 02:28:47

No.

Speaker 5 02:28:48

Right. But he graduate is enough.

Speaker 4 02:28:50

Yeah, but to be a professor you need PhD.

Speaker 2 02:28:53

I'm done with schools.

Speaker 5 02:28:55

This is the last start with ta.

Speaker 6 02:28:56

But I said many times. This is my last time at the.

Speaker 4 02:29:02

Me too.

Speaker 6 02:29:03

I said many times. I also did.

Speaker 5 02:29:11

For me after fifteen years back to school in like. No cat. Thanks. For you guys.

Speaker 2 02:29:20

I.

Speaker 6 02:29:26

Hear my graduates in ten years. I go back to the back first colle. I can now like. I cannot understand. Look professor very well. Yeah. From my English level that time.

Speaker 5 02:29:44

But now it's good, right?

Speaker 6 02:29:47

I can say.

Speaker 5 02:29:51

I go by this way. I come out.

Speaker 4 02:29:53

Yeah. Just go straight and then you'll see. You usually go the door, right?

Speaker 5 02:29:57

Yeah. Okay.

Speaker 4 02:29:59

Are you guys so lost? We just walked like a little bit away.

Speaker 5 02:30:03

Yeah. Every time we come to here. Yeah, both of us. I get lost inside. Yeah. But outside we are okay, right? Only the inside is like.

Speaker 6 02:30:13

Only this building.

Speaker 4 02:30:15

The parking office is right here.

Speaker 6 02:30:17

I know. I. Yeah. I miss a lot myself. So I.

Speaker 5 02:30:25

Parking light here.

Speaker 4 02:30:26

Yeah.

Speaker 5 02:30:27

Yeah. Okay.

Speaker 4 02:30:28

Okay.

Speaker 5 02:30:29

Okay, guys. Take care. Yes. See you tomorrow.

Speaker 6 02:30:34

Yeah. Also this night, right? Tonight.

Speaker 5 02:30:39

Okay, I see you there. That's it. Right?

Speaker 6 02:30:45

We don't have any quiz tomorrow, right?

Speaker 5 02:30:48

No, no, no, no.

Speaker 6 02:30:49

The final quiz is.

Speaker 5 02:30:50

You didn't say right.

Speaker 6 02:30:52

We. We have finished all quiz. Right.

Speaker 4 02:30:54

We have quiz next weekend for this. So we should probably do call.

Speaker 6 02:31:01

Should be the multiple chances.

Speaker 4 02:31:04

I hope so. There's some calculation stuff. You tell me.

Speaker 6 02:31:07

All right, so where will f.

Speaker 4 02:31:13

I will try.

Speaker 5 02:31:15

Do we. Do we say have quiz? Never mention we have quiz.

Speaker 6 02:31:19

Yeah.

Speaker 5 02:31:20

Oh, okay.