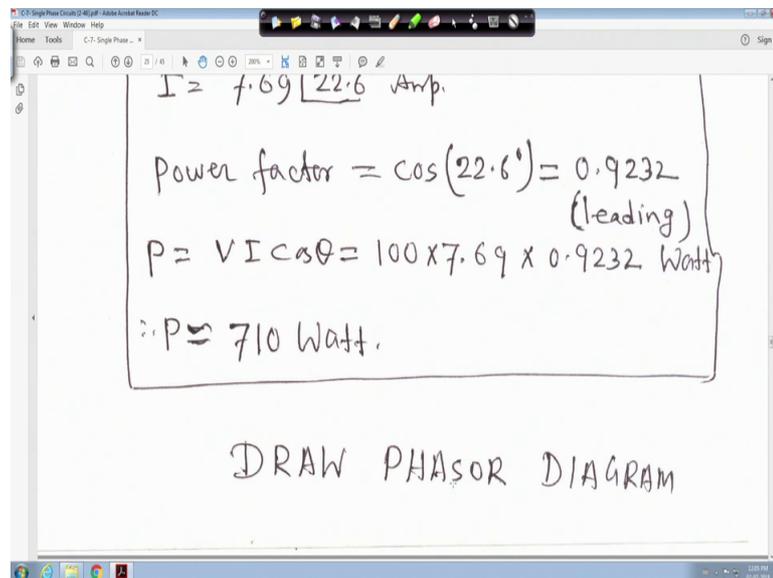


Fundamentals of Electrical Engineering
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Lecture – 43
Single Phase AC Circuits (Contd.)

So, again we are back right. So, this will take another example like this one right.

(Refer Slide Time: 00:26)



The image shows a digital whiteboard with handwritten mathematical expressions. The text is as follows:

$$I = 7.69 \angle 22.6 \text{ Amp.}$$
$$\text{Power factor} = \cos(22.6^\circ) = 0.9232 \text{ (leading)}$$
$$P = VI \cos \theta = 100 \times 7.69 \times 0.9232 \text{ Watt}$$
$$\therefore P \approx 710 \text{ Watt.}$$

DRAW PHASOR DIAGRAM

So, I mean before this while it is this previous example I asked you to draw the phasor diagram right. So, in this case that all power balance everything is shown.

(Refer Slide Time: 00:32)

The image shows a software window with handwritten mathematical work. At the top, there is a partially visible equation: $V_3 = IZ_3 = (7.1 + j2.96) \times 2$. Below this, a boxed result shows $\therefore V_3 = (14.2 + j5.92) \text{ Volt}$. A second boxed result shows $\therefore V_3 = 15.38 \angle 22.6^\circ \text{ Volt}$. Below the boxes, the word "check" is written, followed by the equation $V_1 + V_2 + V_3 = (100 + j0) \text{ Volt}$.

But it is given $V_1 + V_2 + V_3$ it is a Phasor quantity right.

(Refer Slide Time: 00:36)

The image shows a software window with handwritten mathematical work. The first equation is $V_1 = IZ_1 = (7.1 + j2.96)(4 + j3)$. Below it, a boxed result shows $\therefore V_1 = (19.53 + j33.14) \text{ Volt} = 38.47 \angle 59.5^\circ \text{ Volt}$. The second equation is $V_2 = IZ_2 = (7.1 + j2.96)(6 - j8)$. Below it, a boxed result shows $\therefore V_2 = (66.27 - j39.06) \text{ Volt} = 76.92 \angle -30.5^\circ$. At the bottom, the equation $V_3 = IZ_3 = (7.1 + j2.96) \times 2$ is written.

So, V_1 actually here your V_1 was 38.47 your angle 59.5 degree. So, in this case you just hold on. So, in this case this is your V_1 , the this is your V_1 right similarly this is your V_2 and this is your let me move little bit up just hold on.

(Refer Slide Time: 01:08)

The image shows a software window with handwritten calculations for AC circuit analysis. The calculations are as follows:

$$\therefore V_1 = (19.53 + j33.14) \text{ Volt} \approx 38.47 \angle 59.5^\circ \text{ Volt}$$

$$V_2 = IZ_2 = (7.1 + j2.96)(6 - j8) \approx 38.47 \angle 59.5^\circ$$

$$\therefore V_2 = (66.27 - j39.06) \text{ Volt} = 76.92 \angle -30.5^\circ$$

$$V_3 = IZ_3 = (7.1 + j2.96) \times 2$$

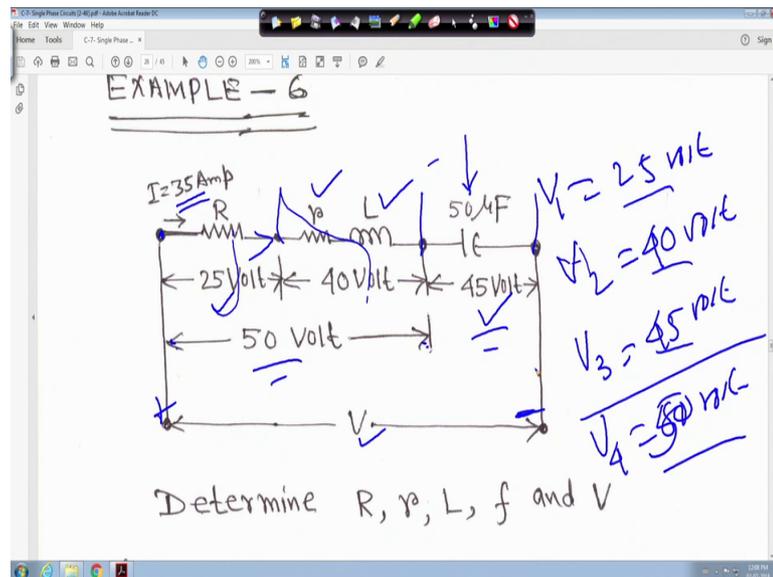
$$\therefore V_3 = (14.2 + j5.92) \text{ Volt}$$

Handwritten notes on the right side of the calculations include: $+76.92$, $\angle -30.5^\circ$, and $100 \angle 0^\circ$.

So, this is your V 3 right. So, now this is your V 1. So, V 1 is 30; I am writing here 38.47, angle 59, you have to do it the way you do they are your call for vector, vector you have studied same thing right. So, V 1 then plus V 2, V 2 is this one 76.92, angle, minus 30.5 degree then plus this one V 3; V 3 say here I am writing like this 14.2, plus j 15.92, right if you add all this thing you will find your what you call this will become your 100 angle, 0 degree right.

So; that means, you have to do not add the magnitude you have to consider this phase the 38.47 means the angle 59 means, 38.47 cosine of 59.5 degree plus j 38.47 sine 59.5 degree similarly, for this one and this one already it is real and numeric it is written here. So, that is why I have written right, so understandable to you. So, next example, we will take this one this, this is a very interesting example look one example will help you a lot.

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For example, this is your a simple series circuit current magnitude is given flowing through this I is equal to your 35 ampere. So, this one you know this is instantaneous polarity says, this is plus this is minus right, and this current is flowing through your flowing through this circuit series R and this is the by applied voltage V . So, across R the voltage is given your 25 volt, this is magnitude say it is 25 volt angles are not known. And across this thing, say, it is an inductor which has resistance also small r and inductance say L . So, across this one say voltage is equal to 40 volt this is magnitude right. And this is a capacitor across which the voltage is say V_3 . So, V_3 is equal to it is given 45 volt. So, it is 45 volts this is magnitude right, this is magnitude. And across from this point to this point from this point to this point this voltage say V_4 it is given 50 volt, it is given 50 volt right.

So, look if, you like a DC circuit do not add like this right, if you get 40 plus 25 it is 65 it is not correct because, you have to consider the Phase angle right, but we do not know only magnitudes are known; magnitudes are known that is why from here to here it is 50 volt; that means, it has some phase angle we will see that. And this voltage across the capacitor is 45 volt. So, these are all magnitude you have to Determine the capital this just let me clear it this, this R this R then the small r then L right, then the frequency of that supply voltage this f and the voltage V that is the supply voltage V . These are the things we have to Determine. And this is an current magnitude of the current that is given say I is equal to 35 ampere right.

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$$\text{Soln. } V_1 = 25 \text{ Volt; } V_2 = 40 \text{ Volt;}$$

$$V_3 = 45 \text{ Volt. } \quad V_4 = \underline{\underline{50 \text{ Volt}}}$$

$$\frac{V_3}{X_C} = I = 35$$

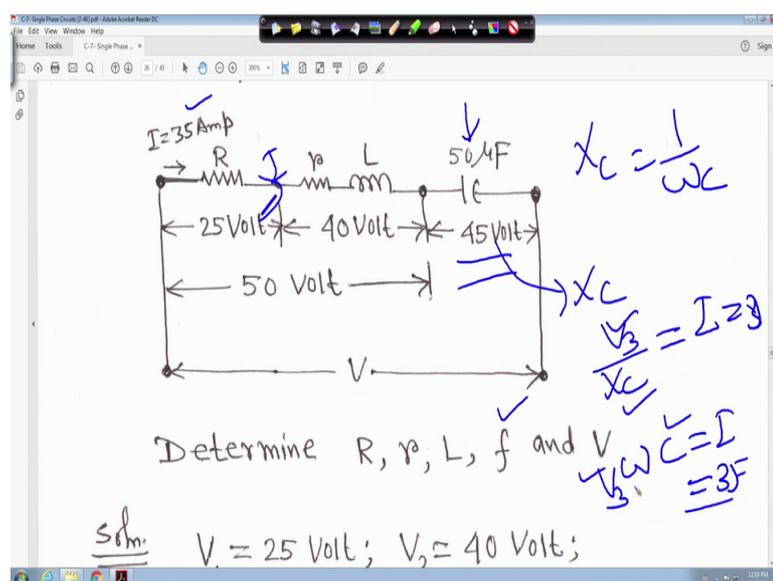
$$\therefore \frac{45}{\frac{1}{\omega C}} = 35 \Rightarrow \frac{45}{\frac{1}{2\pi f C}} = 35$$

$$\therefore f = 2.475 \text{ kHz.}$$

So now, when we will solve this problem we are assuming that your V 1 is equal to I told you 25 volt, V 2 is equal to 40 volt, V 3 is equal to 45 volt right, and this voltage 50 you assume V 4 is equal to 50 volt, say V 4; these are all magnitude V 4 is equal to say 50 volt right.

So, now in general that magnitude of the current I is equal to say V 3 upon x e for example. So, let me clear it.

(Refer Slide Time: 04:55)



For example, in this circuit you have to from your intuition you have to find out this is the current flowing; this is the current flowing, through the circuit I, this voltage magnitude 55 your volt is known that is your V 3 and capacitor is 50 micro Farad right. So, then this is that your what you call the current magnitude and this if this if it is reactance is x c, right then V by, x c, is equal to your I, that is your 35, ampere these are magnitude this is also magnitude, this is also magnitude, but x c is equal to, 1 upon omega c right; that means, if you put x c is equal to 1 upon omega c it will be V omega c, is equal to I, is equal to 35 this voltage, this is actually it is V 3 we have taken. So, this is V 3 this is V 3 right.

So, V c is known V 3 is known omega is equal to 2 pi f from which you will get the f. So, this way you can find out what is the value of the f right.

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$$V_3 = 45 \text{ Volt.}$$

$$\frac{V_3}{x_c} = I = 35$$

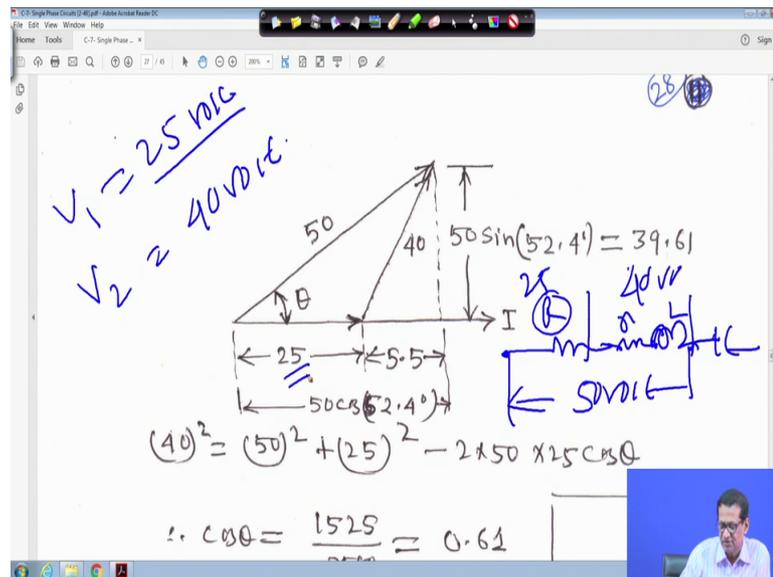
$$\therefore \frac{45}{1/\omega c} = 35 \Rightarrow \frac{45}{1/2\pi f c} = 35$$

$$\therefore f = 2.475 \text{ kHz,}$$

$$R = \frac{V_1}{I} = \frac{25}{35} = 0.714 \Omega$$

So, if you look into this. So, V 3 upon x is. So, x is equal to 1 upon omega c. So, from which we will get f is equal to 2.475 kilo hertz right, kilo hertz. Similarly your V 1 the voltage across the resistance the capital R is 25 volts. So, this is 25 volt and I is equal to this is 25 volt is equal to magnitude 35 ampere, so capital R is equal to 0.714 Ohm right. So, we got capital R we got frequency also that 2.475 kilo hertz now next is that from this diagram.

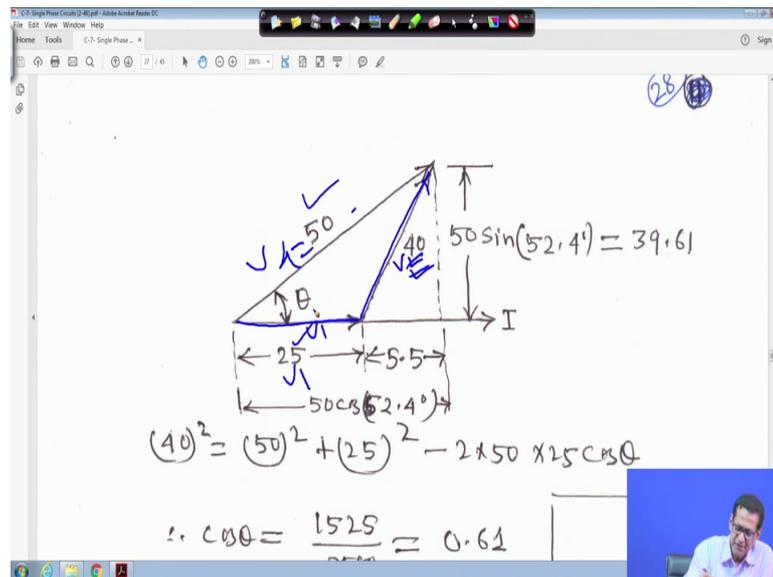
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Now, question is it is given like this look the circuit is like this that V 1 that resists, voltage across the, capital R is 25 volt this is my V 1 right and V 2, V 2 is given 40 volt, right 40 volt. Now, circuit were like this, this is my capital R this is my small r then inductance L right, and then my capacitance is that this is small r this is L. Now, voltage, from this point to this point right, this is given your 50 volt right, this is your 50 volt, that is your V 4, this is your given 50 volt.

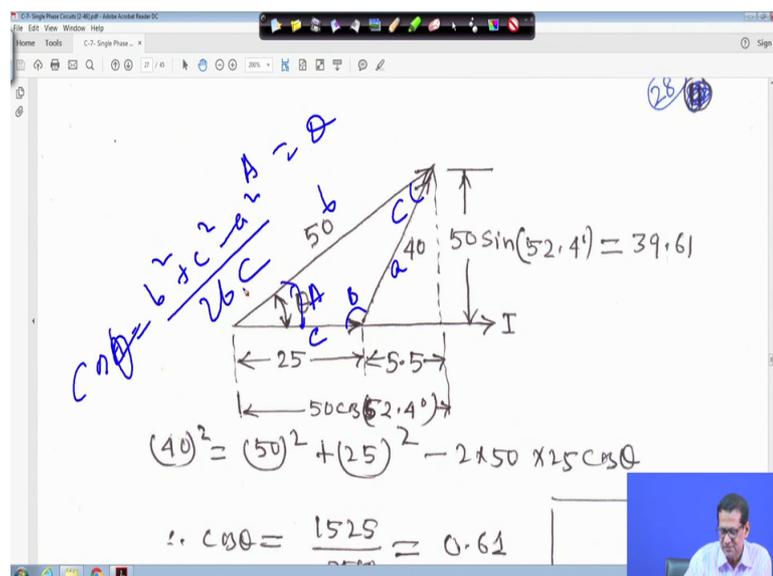
So, this voltage across this one R is given it is 25 volt that is V 1 across this also it is given that inductor it is 40 volt right, but their Phasor quantity that means there must be some angle. So, in this case as V 1 is 20 or what we call that V 1 voltage drop across R that is your 25 volt is given. So, let me clear it. So, this one is taken say as a reference say 25 volt right and V 2 this is your V 1 right.

(Refer Slide Time: 07:40)



And your V_2 is this one that is your 40 volt this is your V_1 , and this is your V_2 right. And this voltage V_4 is equal to V and this angle is making theta because these voltage magnitudes are given right. So, in that case what will happen that how then we have first, we have to this all the magnitudes are known right. So, we have to find out the angle that you have to go for that cosine law for the triangle. So, generally you know that suppose for example: here it itself I making it helps.

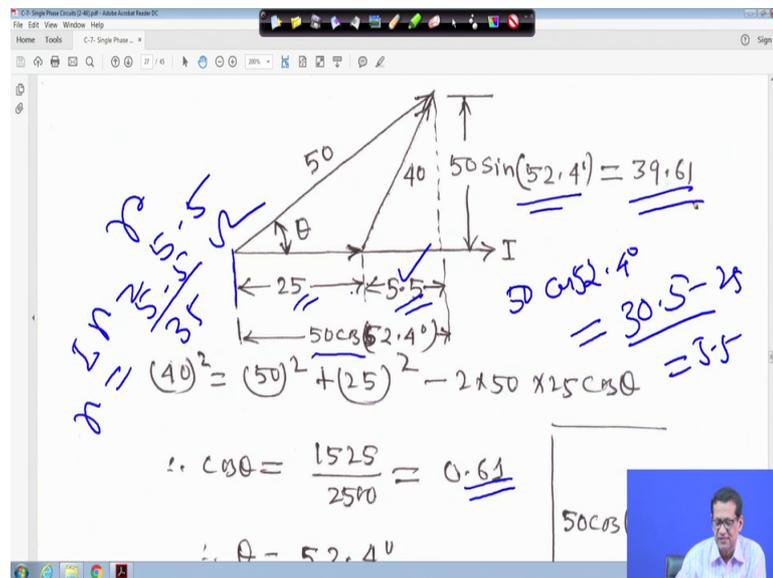
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Suppose this angle is A. So, its opposite arm is a. Suppose this angle is B its opposite arm is b and this angle say it is C capital C right, so its opposite arm is C right. You know rectangle; from that you know in general you know this is a here A here I have taken A means A is equal to theta right. So, from that you know that cosine A is equal to b square plus c square minus a square divided by 2bc you know that right. So, in that case cosine A means, it is cosine theta right this is theta A cosine A is equal to your b square plus c square. So, this is my b. So, here it will be 50 square plus c square means, 25 square minus a square minus 40 square right, is equal to you have divided by 2 into b into c.

So, I could be using that formula only. Let me clear it we have written this formula right. So, this is actually I told you how we will do it that cosine your, triangle that you have on class 11 mathematics has take trigonometry right. So, this one you can write 40 square is equal to 50 square plus 25 square minus 25 to 25 cos theta right.

(Refer Slide Time: 09:29)



So, from here, you will get cos theta is equal to your let me clear this one. So, from this you will get cos theta is equal to 0.61 right, and this side that means, your, the horizontal side it will be 50 cos your 50, cos your 52.4 right. This from here to here this is your 50 cos 52.4 degree, because theta will be your 52.4 degree right. So that means, to if you if you take 50 cos 52.4 degree it will actually become, say approximately 30.5 right. That means, this 25 was also their voltage drop across the capital R then your 30.5 minus this

25, minus 25 is equal to 5.5. So, this is your 5.5. This is the voltage drop, across your small r right. So, voltage drop across small r is 5.5 right.

That means I into small r, is equal to 5.5. I is equal to 35 ampere is given. So, small r is equal to 5.5 by, your 35, Ohm calculations given later right and this vertical one is 50 sine 52.4 degree. So, it is 39.61 right. So, let me clear it.

(Refer Slide Time: 11:01)

Handwritten calculations on a whiteboard:

$$\therefore \cos\theta = \frac{25}{50} = 0.61$$

$$\therefore \theta = 52.4^\circ$$

Voltage drop across $r = 5.5$ Volt

Voltage drop across $L = 39.61$ Volt.

$$\therefore I r = 5.5 \quad \therefore 35 r = 5.5 \quad \therefore r =$$

On the right side of the whiteboard:

$$50 \cos(52.4^\circ)$$

$$= 50 \times 0.61$$

$$= 30.5$$

So, from this you are getting theta is equal to 52.5 degree, and this I told you it will be 30.5 voltage drop across r will be 5.5 voltage.

(Refer Slide Time: 11:16)

Handwritten phasor diagram and calculations on a whiteboard:

Diagram: A phasor diagram showing a hypotenuse of length 50. The horizontal component is 25 and the vertical component is 40. The angle between the hypotenuse and the horizontal axis is θ . The horizontal axis is labeled I . The vertical component is labeled $50 \sin(52.4^\circ) = 39.61$. The horizontal component is labeled $50 \cos(52.4^\circ)$. The horizontal axis is divided into segments of 25 and 5.5. The total horizontal length is 30.5. The vertical component is labeled $V_L = 39.61$.

Calculations:

$$(40)^2 = (50)^2 + (25)^2 - 2 \times 50 \times 25 \cos\theta$$

$$\therefore \cos\theta = \frac{1525}{2500} = 0.61$$

On the left side of the whiteboard, there is a circled expression: $r + jL$.

And voltage drop across L here it is voltage. This is your voltage drop across L will be 39.61 degree right, because if you take it is this thing it is r plus $j L \omega$ right, this is the impedance of that your inductor. So, this is small r right and this for this, vertical projection is 39.6. So, this is the voltage drop across the inductor that is your V_L is equal to 39.61 volt. So, let me clear it.

(Refer Slide Time: 11:45)

Handwritten notes on a whiteboard:

Voltage drop across L = 39.61 Volt.

$$\therefore I r = 5.5 \quad \therefore 35 r = 5.5 \quad (\therefore r = 0.157 \Omega)$$

$$I X_L = 39.61 \quad \therefore \text{---}$$

$$\therefore 35 \times L \times 2\pi \times 2.475 \times 1000 = 39.61$$

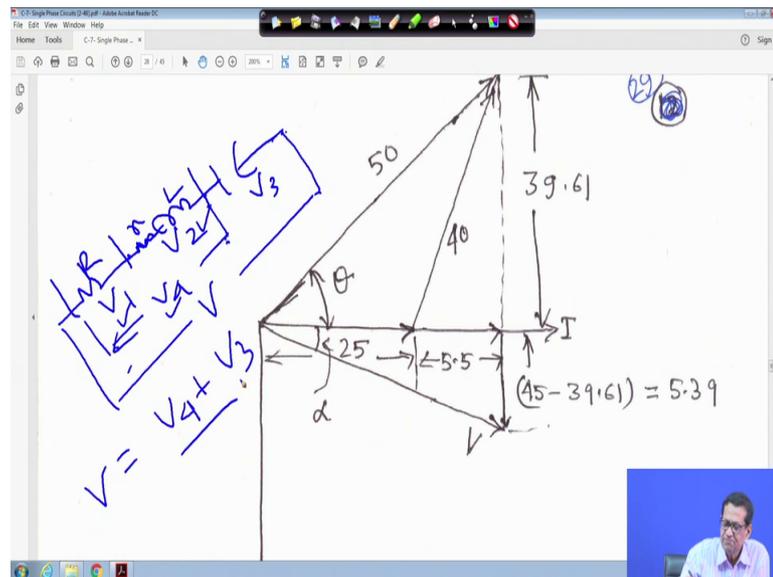
$$\therefore L = 0.073 \text{ mH} \quad X_L = L \omega$$

$f = 2.475 \text{ kHz}$
 $= 2.475 \times 10^3 \text{ Hz}$
 $L \times 2\pi f$

So, here I am writing the voltage drop across L is 39.61 volt. So, If I told you 5.5. So, r is equal to 0.157 Ohm. Similarly, I into X_L these are all magnitude 39.61 X_L is your $L \omega$.

So, L into 2π and ω actually, we got that you are what you call your 2π your, a ω is equal to $2 \pi f$ this one here, here X_L , is equal to $L \omega$, it is L into, 2π into f right. So, f we have got, 2.475 kilo hertz right is equal to 2.475 in to 1000. So, that is why this, this is multiplied by it is a converted to hertz it was kilo hertz. So, multiple and this is 2π and this is L is equal to 39.6. If, you calculate this L will become 0.073 mille Henry right. So, this way it has been done.

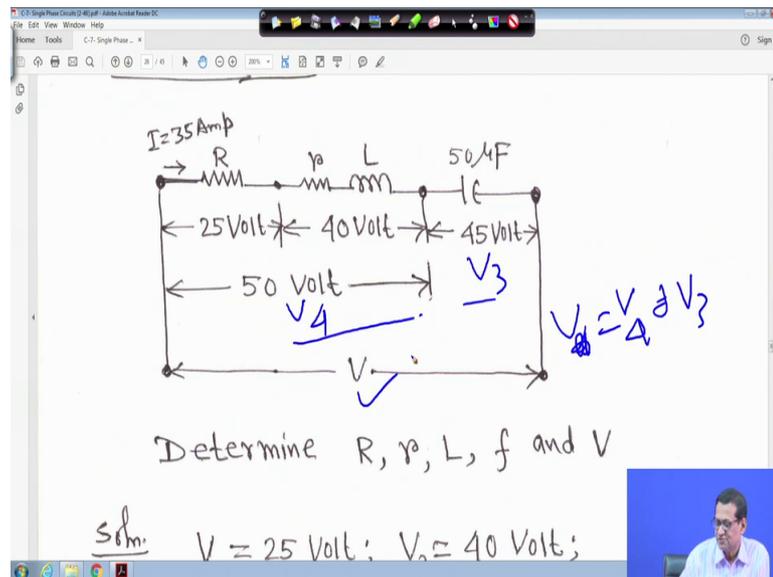
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Now, next is that what do you call the supply voltage V right. Supply voltage V actually, it a circuit was like this no it was capital R then the inductors just let me clear this is capital R then your small r then the inductor then the capacitor right and what you call this r this is L and this is your capital R right. So, this why and supply voltage was what you call this one, this one was your supply voltage right that is your V this is the supply voltage. This is across this it is V_1 , across this is V_2 , across this it is V_3 right. And from this point to this point from this point to this point we took it in V_4 .

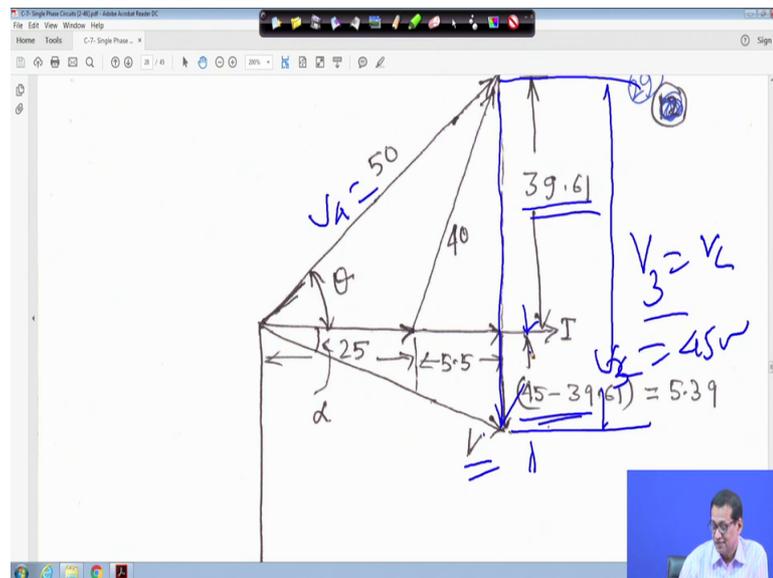
So, V_1 is 25 volt, V_2 is equal to 40 volt and V_4 is equal to what you call 50 volt right and V_3 is equal to your 45 volt right. So, from that you are from the Phasor thing we can write that V actually is equal to V_4 plus because from here to here it is V_4 look at the diagram plus V_3 . I mean if, I come to the diagram let me clear it; if, I come to the circuit diagram it is a Phasor quantity that we do vector same thing.

(Refer Slide Time: 14:08)



If, I come to the Phasor diagram this was my V_3 and this was my V_4 . So, my V_4 is equal to I ; sorry, V is equal to V_4 plus V_3 it is a Phasor every time I am not putting arrow on top it is understandable. So, V is equal to V_4 plus V_3 that is equal to V right. So, in the Phasor form if, you make it, it will be something like this.

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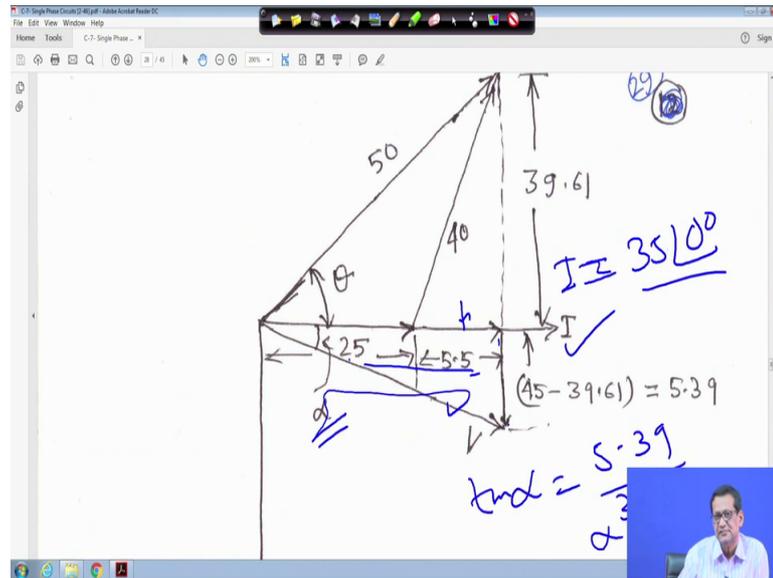


So, this is your V is equal to right, is equal to this V_4 this is your V_4 and this total from here to here right, from here to here V_4 then this voltage and this voltage from here to here right, it is your V your V_1, V_2, V_3 . The voltage across the capacitor that is V_3 say

V₃ is equal to V_c, and this is actually, 45 volt right. So, in the 5th Phase in the diagram Triangle diagram we have seen this was 39.61; that means, this from here to here this portion will be 45 minus 39.61 because V is equal to V₄ plus your V₃ the way you make this is your V₃ this is your V₃ right, this way you have to take this is very interesting problem this one right.

So, then if you take the difference, then this portion will be 45 minus 39.61.

(Refer Slide Time: 15:35)



This means this is our, current ripple this I, this b is a 25 volt 5.5 by the voltage drop across I. So, I basically, we have taken that say, 35 angle 0 degree. This is my reference point reference current. So, voltage here it is lagging right; it is lagging voltage is lagging because voltage Phasor is coming here. So now, we have to, compute that this angle, angle between current and voltage this angle is alpha; this angle is given here alpha. So, tan alpha will be if you look into that. So, tan alpha will be this is my height 5.39, divided by 25 plus 5.5, this will be 35.50 alpha is equal to tan inverse this one right.

So, this one we have computed, this one we have computed. So, this is that is what V₃ is drawn here because voltage across capacitor. So, it is drawn here that means this one right it is vertically it is this one whatever I told.

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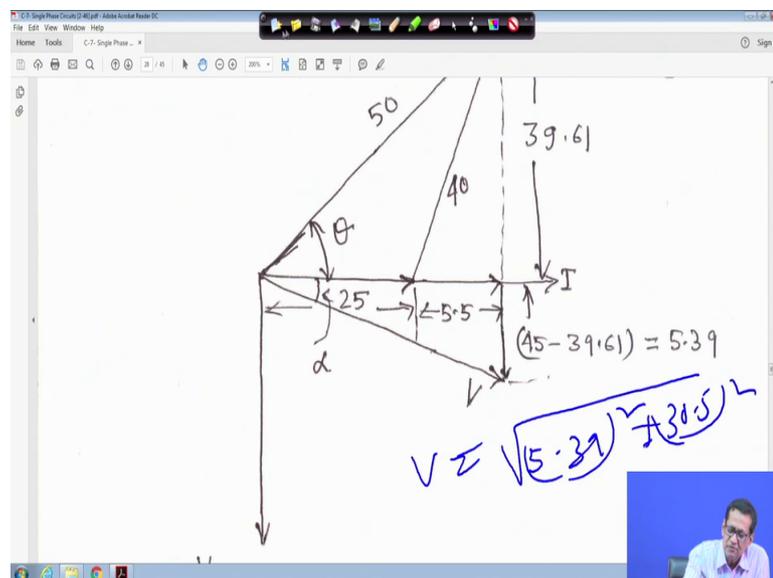
The screenshot shows a digital whiteboard with the following handwritten content:

- A downward arrow pointing to the text $V_3 = 45 \text{ Volt}$.
- The equation $\therefore V = \sqrt{(25 + 5.5)^2 + (5.39)^2}$.
- The result $\therefore V = 31 \text{ Volt. (} \approx 30.972 \text{ Volt)}$.
- The phase angle calculation $\alpha = \tan^{-1}\left(\frac{5.39}{30.5}\right) = 10^\circ$.

A small video inset in the bottom right corner shows a man speaking.

So, that means, V will be is and magnitude will be here and this magnitude of the voltage here magnitude of the voltage will be V is equal to right.

(Refer Slide Time: 16:39)



It is a right angle triangle. So, it will be your root over, 5.39 square and this length is 25 plus 5.5, so 30.5 square volt right whatever it comes.

So that is why just minute. So, that is why these calculations have been made this is your approximately 31 volt, alpha is equal to I told you it will be tan inverse 5.39 upon 30.5, 10 degree.

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$$\alpha = \tan^{-1}\left(\frac{5.39}{30.5}\right) = 10^\circ$$

$$\text{Power factor} = \cos \alpha = \cos(10^\circ) = 0.9848$$

$$P = (35)^2 (0.714 + 0.157) = 1.0669 \text{ kW}$$
 Also

$$P = VI \cos \alpha = 31 \times 35 \times 0.9848 \approx 1.0669 \text{ kW}$$

And power factor will be $\cos 10$ degree 0.9848 right, and voltage across that you are what you call there are two what you call resistance this is capital R and this is your small r. So, total added and current is I. So, I square r it comes 1.0669 kilowatt. Similarly, if you make P, P is equal to VI cos alpha, so 31 into 35 into 0.9848 because power factor is 0.9. So, this is your 1.0669, kilowatt. So, this is your answer.

So, you have to it has to match I square r must be is equal to V I cos theta it has to match.

(Refer Slide Time: 17:0)

EXAMPLE - I

$232 \angle 0^\circ$
 231 Volt
 50 Hz

I
 I_L
 C
 LOAD
 10 kVA
 0.8 PF
 (lagging)

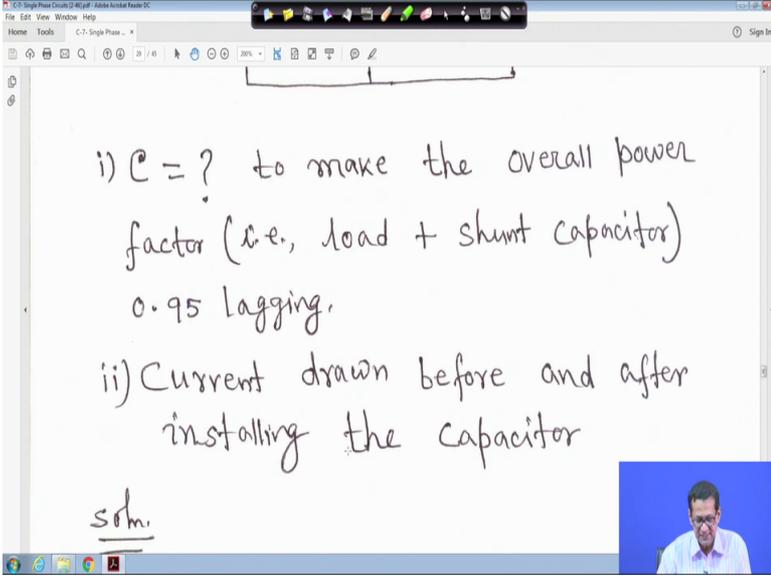
0.95

i) $C = ?$ to make the overall power factor (i.e. load + shunt capacitor)

Now, next another example, this example is that you have a 231 whenever nothing is mentioned; that means, 231 volt means it is RMS value and all the time we assume it is angle say unless and until it is specified say 231 angle, 0 degree right. And another thing is the load is given 0.8 power factor lagging, when it said that lagging; that means, current actually lagging from the voltage whenever gives that power fact that 0.8 power factor lagging means that current lags the voltage right.

So, current is lagging right and it is given that you are what you call this is the load 10 kilo volt ampere that is 10000 volt ampere and this is the load. Now, what we have to do is that suppose we want to improve the power factor to say 0.95 it was 0.8 but now we want to that power factor to 0.9 for which we have connected one shunt capacitor right. So, we have to find out what is I what is IC or C value and what is the load current after connecting the capacitor. That means, this is the problem define.

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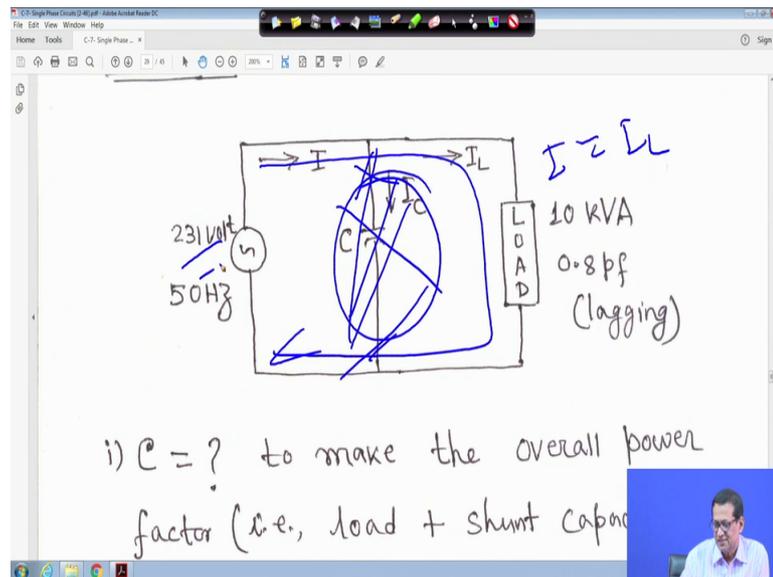
The image shows a screenshot of a whiteboard interface. The whiteboard contains the following handwritten text:

- i) $C = ?$ to make the overall power factor (i.e., load + shunt capacitor) 0.95 lagging.
- ii) Current drawn before and after installing the capacitor

Below the text, the word "soln." is written and underlined. In the bottom right corner of the whiteboard area, there is a small video inset showing a man in a white shirt speaking.

So, see how what is the value of C to make the overall power factor that is load plus shunt capacitor 0.95 lagging and current drawn before and after installing the capacitor look when we are before installing the capacitor.

(Refer Slide Time: 19:11)



This circuit this should not be there it is not there at that time I should be is equal to I_L , this is not there, this is not connected it is simple circuit right it is simple circuit. So, suppose this is you remove this is you remove.

So, current will flow like this, this is you remove and this voltage source is there right. So, this at that time I is equal to I_L . So, at the time we have to find out what is the current right and after putting this we want that combined power factor, should be 0.95, lagging right; that means, we have to find combined power factor of this, then for which what will be the value of the C and I_C etcetera. I everything we have to compute.

(Refer Slide Time: 19:54)

Before installing the capacitor, the current is only drawn by the load, i.e.,

$$I_L = \frac{\text{Apparent Power of Load}}{\text{Voltage}}$$
$$\therefore I_L = \frac{10 \times 10^3}{231} = 43.29 \text{ Amp}$$

The screenshot shows a whiteboard with the above text and calculation. A small video inset in the bottom right corner shows a man speaking.

So, for that when before installing the capacitor the current is already drawn by the load I told you at the time capacitor is not there you remove the capacitor. So, I_L will be what you call apparent power of load by voltage. So, 10 KVA means, 10,000 volt ampere divided by 231 volts. The supply voltage is given it is 43.29 your what you call ampere right. So, it is 43.29 ampere. Now, it is power factor is given lagging 0.8 right.

(Refer Slide Time: 20:23)

and $\cos\theta = 0.8$

$$\therefore \theta = \cos^{-1}(0.8) = 36.9^\circ \text{ (lagging)}$$
$$I = 43.29 \angle -36.9^\circ$$

To make overall power factor 0.95 lagging,

The screenshot shows a whiteboard with the above text and calculations. A small video inset in the bottom right corner shows a man speaking.

So, power factor is your what you call it is 36.9; that means, the current actually, just a minute, the current actually it is, 43.29, angle minus 36.9, degree. Whenever is a lagging

power factor means, the current is lagging right. Now, this is the current 43.29 angle minus 36.9, 9 degree. Now, we have connected a capacitor whenever you solve this problem first you draw the circuit on the notebook then you listen to this video lecture right to make the overall fact power factor, now we have to make it 0.95 lagging right.

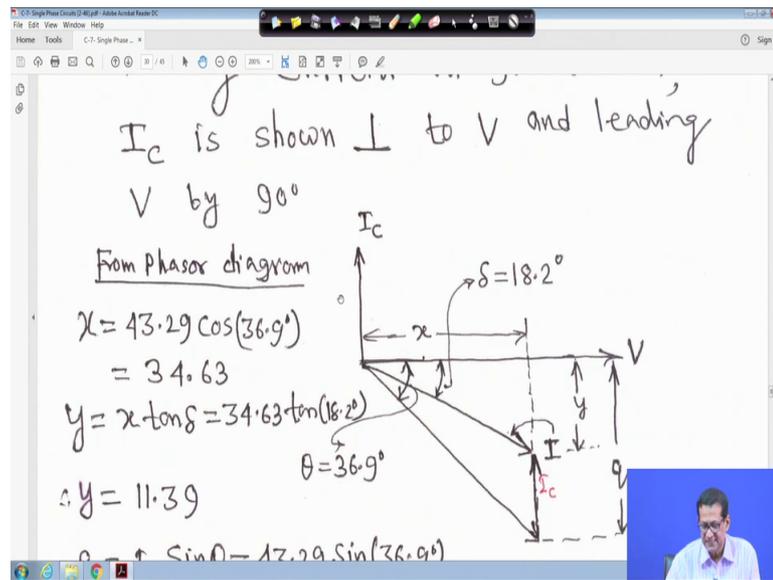
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0.95 lagging,
 $\cos\delta = 0.95$
 $\therefore \delta = 18.2^\circ$ (lagging)

Since the pure capacitor draws a leading current at 90° with V ,
 I_C is shown \perp to V and leading by 90° .

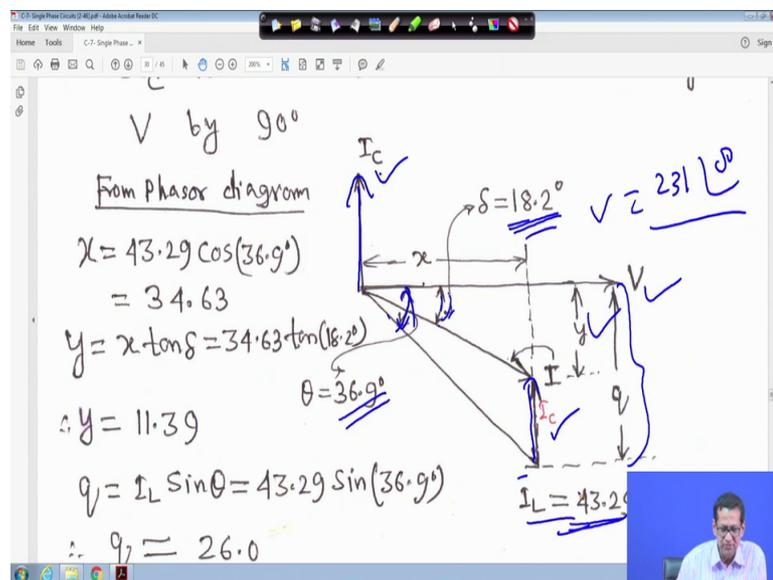
So, in that case what will happen that our cos delta said now new power factor say cos delta is equal to 0.95. So, delta is equal to 18.2 degree it is lagging. Now, since pure capacitor draws a leading current at 90 degree right with V and IC is shown perpendicular this symbol is a perpendicular to V and leading by your V by 90 degree.

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So, if you look into that this one that current this was initially, voltage V is equal to 231, angle 0 degree.

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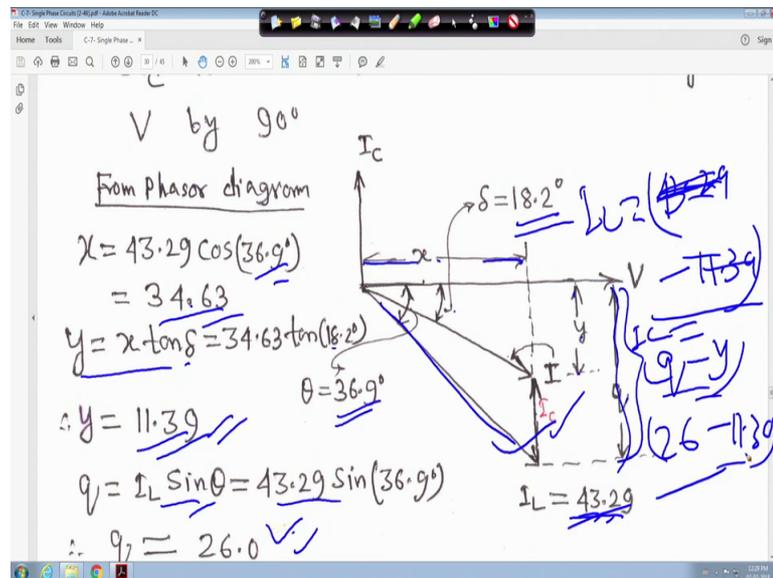


So, we have taken this I_L and this is your 43.29 in the current and this angle is 36 or current is lagging, this is 36.9 degree. Now, after putting the capacitor, capacitor actually capacitive current will reach the voltage by 90 degree. So, this is I_C right. So, same thing we have this is a Phasor, so the way you do what vector same thing we are making it I_C

by reading it is. So, IC right for which this portion that this is the delta this is given this is actually one, power factor should be 0.95.

So, we have got four new power factor angle is 18.2 degree right. We want to improve power factor 2.95. So, this high it is the q and say this is y. So, from which and this is my IL this is my IL that 43 point your 29 degree. Now, if you look into that x is equal to, let me clear it.

(Refer Slide Time: 22:28)



So, x is equal to this is my x this is my x, x is equal to your IL into your cos 36.9, degree this is my x right, so horizontal projection. So, it is 34 point your 63. Now, y is equal to this is my y and this is my delta. So, tan delta is equal to y by x right. Therefore, y is equal to x tan delta right.

So, x we have got 34.63 and tan delta, delta is 18.2 degree because power factor we want 0.95 lagging. So, it is 18.2 degree. So, theta is equal to what you call theta is equal to your 30 your; sorry tan 18.2 degree sorry. So, that mean y is equal to 11.39; that means, this height y is equal to 11.39. So, that means, your IC will be the magnitude of the current this IC will be, 43.29 minus your 11 point whatever it comes 11.39. This is will be your capacitive current magnitude 43.29 minus 11.39. So, this is my I C it is shown by radial right similarly. That means, q is equal to vertical projection IL sine theta.

So, this is my q right. So, it is actually coming how much this thing 43.29 sign 36.9 degree right. So, my q actually is coming, your 26 right; so this is the height this is my 26 right. So, in that case what you call this is we got y, y is equal to what 11.39 and IL, no sorry. This is actually IL sorry vertical one sorry not 43.29 that this is my q it will be q minus y this is my IC sorry not this one q minus y is equal to I C right. So, therefore, IC is equal to q is 26 and y is equal to we got your 11.39 whatever come this is my capacitor current I, I missed it I thought this vertical line this is my I L this is 43.29.

So, it will be q minus y. So, 26 minus 11 point your 39 right.

(Refer Slide Time: 24:46)

The image shows a handwritten derivation on a digital whiteboard. The text is as follows:

Supply Current

$$I = \sqrt{x^2 + y^2} = \sqrt{(34.63)^2 + (11.39)^2}$$

$$\therefore I = 36.46 \text{ Amp.}$$

$$I_c = q - y = (26 - 11.39) = 14.61 \text{ Amp}$$

Now $I_c = \frac{V}{12.61} = \omega C V$

So, this one, if, you do so, this is your supply current will be I now root over x square plus y square. So, 34.63 square plus 11.39 square it will coming now 36.46 ampere and now IC is equal to actually q minus y, there by mistake I took the loop current right. So, because it has written there, so what is it is actually, your q minus y. So, it is coming 14.61 ampere right. So, IC is equal to your omega C V. So, similarly you know v you know omega. So, you know what you call I C. So, you can kinds out what is the value of C right.

(Refer Slide Time: 25:32)

Now $I_c = \frac{V}{\frac{1}{\omega C}} = \omega C V$

$\therefore C = \frac{I_c}{\omega V} = \frac{14.61}{2\pi \times 50 \times 231}$

$\therefore C = 201 \mu F$

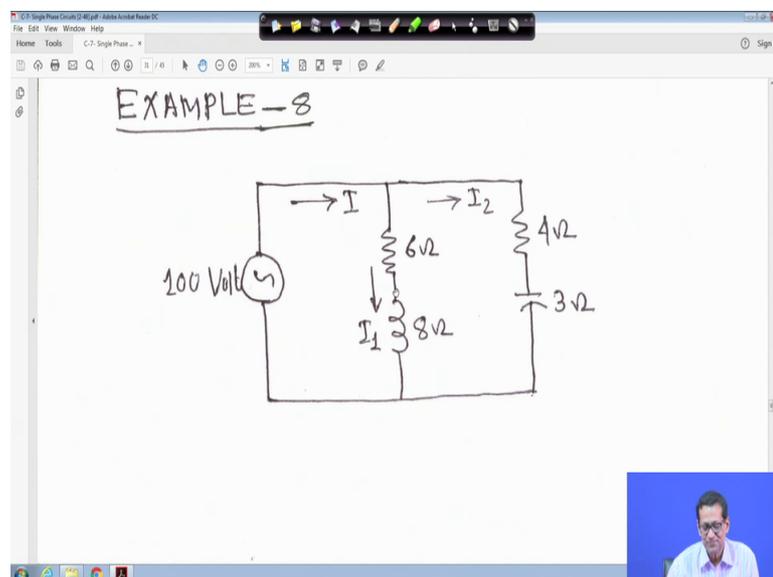
EXAMPLE-8

$\rightarrow I_1$ $\rightarrow I_2$

The image shows a whiteboard with handwritten mathematical equations. The first equation is $I_c = \frac{V}{\frac{1}{\omega C}} = \omega C V$. The second equation is $\therefore C = \frac{I_c}{\omega V} = \frac{14.61}{2\pi \times 50 \times 231}$. The final result is $\therefore C = 201 \mu F$, which is enclosed in a rectangular box. Below the equations, the text "EXAMPLE-8" is written and underlined. At the bottom of the whiteboard, there are two arrows labeled I_1 and I_2 pointing to the right.

So, this one I_c is equal to is coming; sorry that I_c is 14.61 omega is 2 pi, it is 50 hertz is given frequency and voltage is 231. So, C is equal to 201 micro Farad this is the answer right.

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So, similarly another thing is given this a parallel circuit 100 volt means, you take 100 angle 0; 100 angle 0 and it is 6 plus your j 8 and this is your 4 minus j j 3 right. So, if you have to find out I_1 , I_2 right.

(Refer Slide Time: 25:57)

Soln.

$$V = 100\angle 0^\circ \text{ Volt}$$
$$I_1 = \frac{100\angle 0^\circ}{6 + j8} = (6 - j8) = 10\angle -53.2^\circ \text{ Amp}$$
$$I_2 = \frac{100\angle 0^\circ}{4 - j3} = (16 + j12) = 20\angle 36.8^\circ \text{ Amp}$$
$$I = I_1 + I_2 = (6 - j8) + (16 + j12) = 22 + j4 \text{ Amp}$$

So, in this case b is equal to 100 angle 0 simply, I one parallel circuit 100 upon $6 + j8$ you will get 10 angle minus 53.2 degree ampere. I_2 will get 100 angle 0 by $4 - j3$ you will get $16 + j12$ 20 angle 36.8 degree ampere. And I is equal to the way KCL you apply I_1 plus I_2 it will be 22.35 angle 10.3 degree.

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$$I = I_1 + I_2 = (6 - j8) + (16 + j12) = 22 + j4 \text{ Amp}$$
$$\therefore I = 22.35\angle 10.3^\circ \text{ Amp}$$
$$Y = \frac{1}{Z} = \text{Admittance}$$
$$Y_1 = \frac{1}{Z_1} = \frac{1}{6 + j8} = (0.06 - j0.08) \text{ mho}$$
$$Y = \frac{1}{Z} = \frac{1}{10 + j5} = (0.16 + j0.12) \text{ mho}$$

This is the I right, but another way of making another way of easy calculation is that Y is equal to write 1 upon j that is, the Admittance right you write 1 upon z .

(Refer Slide Time: 26:30)

The screenshot shows a presentation slide with handwritten mathematical derivations. At the top, the admittance Y_1 is calculated as $Y_1 = \frac{1}{Z_1} = \frac{1}{(6+j8)} = (0.06 - j0.08) \text{ mho}$. Below this, Y_2 is calculated as $Y_2 = \frac{1}{Z_2} = \frac{1}{(4-j3)} = (0.16 + j0.12) \text{ mho}$. The slide then shows the admittance Y_1 expressed as $Y_1 = 0.06 - j0.08 = g_1 - jb_1$, with a boxed result $\therefore g_1 = 0.06; b_1 = 0.08$. Similarly, Y_2 is expressed as $Y_2 = 0.16 + j0.12 = g_2 - jb_2$. A small video inset of a presenter is visible in the bottom right corner.

Therefore Y_1 is equal to your 1 upon z that is coming 0.06 minus z 0.08 right. So, similarly Y_2 is equal to you make 1 upon j to just numerator and denominator here you multiply 6 minus j 8 . So, it will be 6 square plus 8 square right. Similarly, here also numerator divide by, multiplied by 4 plus j 3 . So, you will get 0.16 plus j , this is admittance unit is more right, so unit is more.

So, similarly that means, Y_1 from here it is coming Y_1 is equal to 0.06 minus j 0.08 , g_1 is equal to then 0.06 , b_1 is equal to 0.08 .

(Refer Slide Time: 27:08)

The screenshot shows a presentation slide with handwritten mathematical derivations. It shows $Y_1 = 0.06 - j0.08 = g_1 - jb_1$ with a boxed result $\therefore g_1 = 0.06; b_1 = 0.08$. Below this, $Y_2 = 0.16 + j0.12 = g_2 - jb_2$ with a boxed result $\therefore g_2 = 0.16; b_2 = -0.12$. At the bottom, a formula for parallel admittances is shown: $\frac{1}{Z} = \frac{1}{Z_1} + \frac{1}{Z_2}$. A small video inset of a presenter is visible in the bottom right corner.

Similarly, Y_2 is equal to $0.16 + j 0.12$ is equal to $g_2 - j b_2$; g_2 is 0.16 and b_2 is equal to -0.12 right. Therefore, like your parallel resistance impedance I have the same thing we do not know 1 upon r is equal to 1 upon r_1 plus 1 upon r_2 .

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$$\frac{1}{Z} = \frac{1}{Z_1} + \frac{1}{Z_2}$$

$$\therefore Y = Y_1 + Y_2 = (g_1 - jb_1) + (g_2 - jb_2)$$

$$\therefore Y = (g_1 + g_2) - j(b_1 + b_2)$$

$$\therefore Y = g - jb$$

$g \Rightarrow$ Conductance

So, here also 1 upon j it is equal to make 1 upon z_1 plus 1 upon z_2 . 1 upon z is Y . So, Y is equal to Y_1 plus Y_2 . So, for parallel circuit Admittance has to be added the way you add resistance in series. So, if you add this right it will become Y is equal to g minus $j b$ right this way; g is called Conductance b is called Susceptance right.

(Refer Slide Time: 27:47)

$$\therefore Y = g - jb$$

$$g \Rightarrow \text{Conductance}$$

$$b \Rightarrow \text{Susceptance}$$

$$g = g_1 + g_2 = (0.06 + 0.16) = 0.22$$

$$b = b_1 + b_2 = 0.08 - 0.12 = -0.04$$

$$\therefore Y = g - jb = (0.22 - j(-0.04))$$

So, g is equal to g_1 plus g_2 ; so g_2 . So, it will be 0.22 and b will be is equal to b_1 plus b_2 it will be 0.08 minus 0.12 .

(Refer Slide Time: 27:57)

$$b = b_1 + b_2 = 0.08 - 0.12 = -0.04$$

$$\therefore Y = g - jb = (0.22 - j(-0.04))$$

$$\therefore Y = (0.22 + j0.04) \text{ mho}$$

Now

$$I = \frac{V}{Z} = YV = (100\angle 0^\circ)(0.22 + j0.04)$$

$$\therefore I = 22.35\angle 10.3^\circ \text{ Amp}$$

$$I_1 = (100\angle 0^\circ)(0.06 - j0.08) = (6 - j8) = 10\angle -53.2^\circ \text{ Amp}$$

So, Y is equal to g minus jb . So, it will be 0.22 plus j 0.04 more right. Now, I is equal to V by Z , but 1 by Z is equal to I therefore, it will be YV .

(Refer Slide Time: 28:12)

$$Y = (0.22 + j0.04) \text{ mho}$$

Now

$$I = \frac{V}{Z} = YV = (100\angle 0^\circ)(0.22 + j0.04)$$

$$\therefore I = 22.35\angle 10.3^\circ \text{ Amp}$$

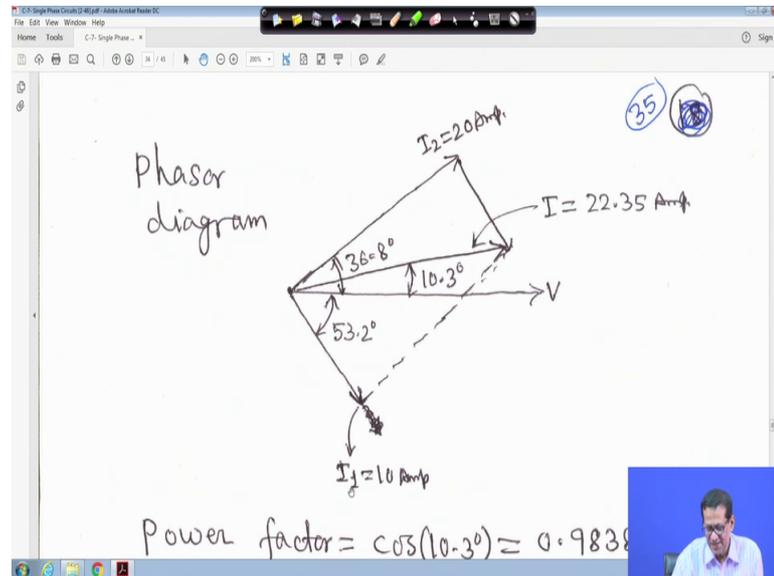
$$I_1 = (100\angle 0^\circ)(0.06 - j0.08) = (6 - j8) = 10\angle -53.2^\circ \text{ Amp}$$

$$I_2 = (100\angle 0^\circ)(0.16 + j0.12) = (16 + j12) = 20\angle 36.8^\circ \text{ Amp}$$

So, b is 100 angle 0 and this is your Y if you multiply, I will become 22.35 angle 10.3 degree Amp is same as before right. Similarly, I_1 is equal to V into your Y_1 . So, it will become your 10 angle minus 53.2 degree ampere same as before and I_2 is equal to 100

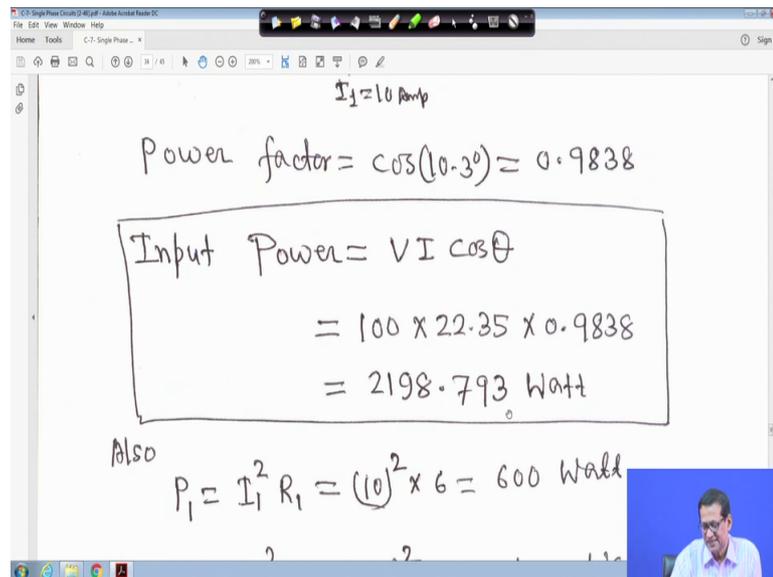
angle 0 into your what you call that your Y 2. So, it may if you do. So, it will become 20 angle 36.8 degree ampere same as before both impedance and admittance both taken together and got the same answer.

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So, admittance one will be easier because calculate, calculate and you can easily convert to polar to rectangular, rectangular to polar. And this is the Phasor diagram V is taken as a reference right and your I 1 10 ampere lagging from V 53.2 degree, I 2 is 20 ampere leading by 36.8 degree and resultant current I is leading from b by 10.3 degree. So, this is what you call this is 10.3 degrees of angle between the voltage and the current I, so this is my power factor angle right.

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$I_1 = 10 \text{ Amp}$

Power factor = $\cos(10.3^\circ) = 0.9838$

Input Power = $VI \cos \theta$

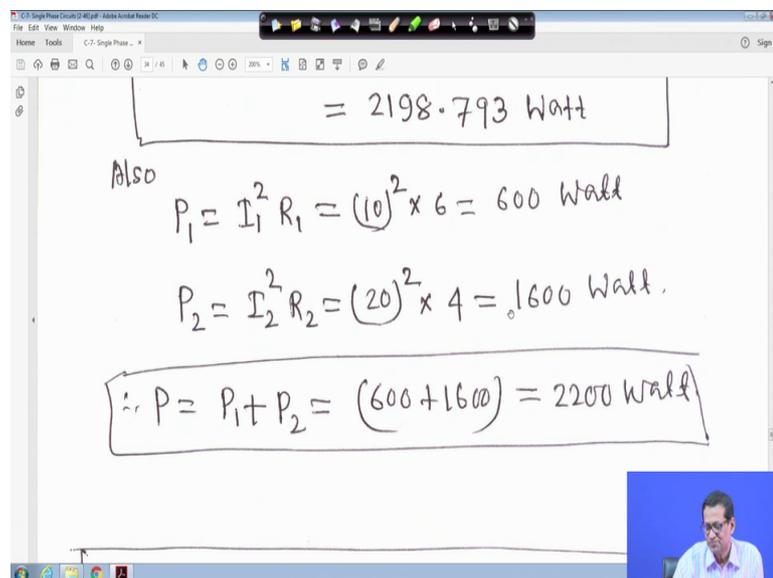
$$= 100 \times 22.35 \times 0.9838$$
$$= 2198.793 \text{ Watt}$$

Also

$$P_1 = I_1^2 R_1 = (10)^2 \times 6 = 600 \text{ Watt}$$

So, power factor is equal to cosine 10.3 degrees. So, 0.9838 and Input Power is equal to $VI \cos \theta$ it is 2198.793 Watt right.

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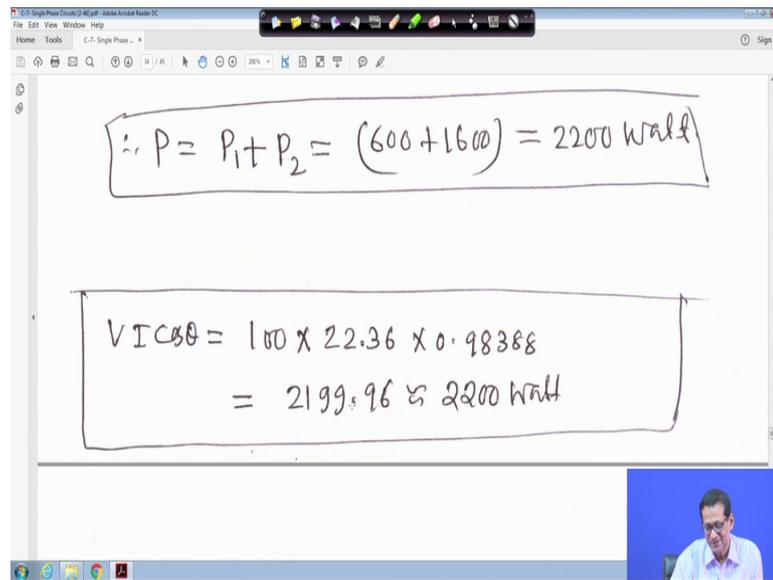
$= 2198.793 \text{ Watt}$

Also

$$P_1 = I_1^2 R_1 = (10)^2 \times 6 = 600 \text{ Watt}$$
$$P_2 = I_2^2 R_2 = (20)^2 \times 4 = 1600 \text{ Watt}$$
$$\therefore P = P_1 + P_2 = (600 + 1600) = 2200 \text{ Watt}$$

So, similarly if you make P_1 is equal to I_1 square into R_1 that is magnitude of the Current 10 square into 6 for branch 1, it is 600 Watt. For branch 2 if you make I_2 square into R_2 it is 20 square into 4, 1600 Watt. Total is 2200 Watt here it is coming 2198.793, because this decimal place is truncated if you take up to three decimal places or here you take up to five decimal places, you will get 2200 Watt.

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The image shows a screenshot of a presentation slide with two handwritten equations. The first equation is $\therefore P = P_1 + P_2 = (600 + 1600) = 2200 \text{ watt}$. The second equation is $VIC_{\theta\theta} = 100 \times 22.36 \times 0.98388 = 2199.96 \approx 2200 \text{ watt}$. A small video inset in the bottom right corner shows a man speaking.

For example, power factor I have taken the fifth decimal place. So, in that case it is coming to one 2199.96 which is 2200 Watt for a check, and here you took up to four decimal place right, that is why it is showing to 198.793, but it just match right. So, here it is matching, right.

Thank you very much. We will be back again.