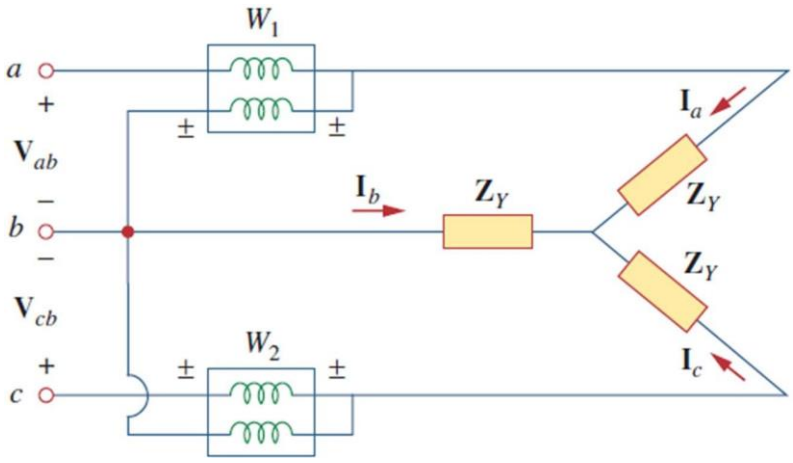
Experiment No.9 **Date:03/12/2021**

Three Phase Systems (Star-Star/Delta) and Power Measurement

Objectives:

1. To understand three phase balanced system star-star and star-delta
2. To measure three phase power using two wattmeter method.

Circuit

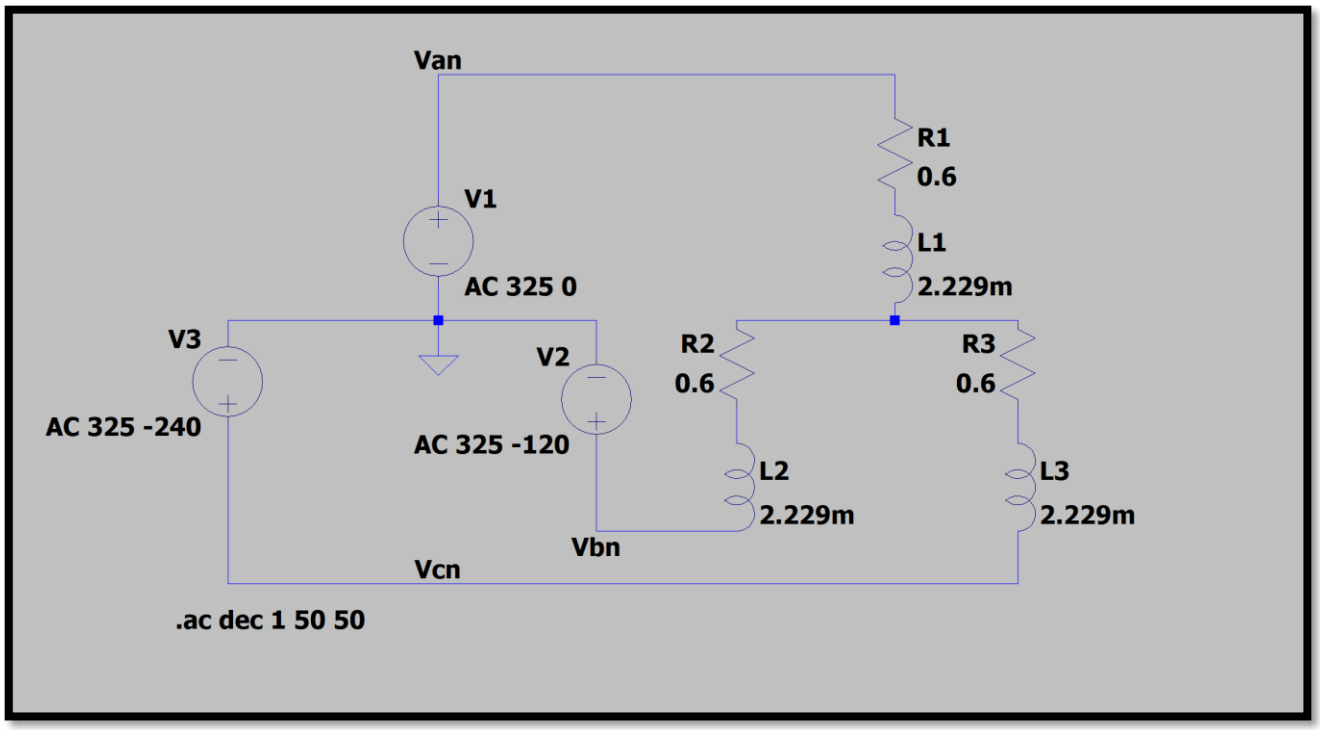


1. **R-Load:**

S. No	Parameter to be measured	Wattmeter 1 P1=$V_L I_L \cos \varphi 1$	Wattmeter 2 P2=$V_L I_L \cos \varphi 1$	Real Power P=P1+P2	Reactive Power Q=$\sqrt{3}$(P2-P1)	Power Factor cosϕ= cos(tan^1(Q/P))
1	Voltage (RMS)	398.04 30	398.04 90	264056.862	0	1
2	Current (RMS)	383.01 0	383.01 120			
3	Phase Angle difference	30	-30			
4	Power	132028.431	132028.431			
	$\varphi 1 = \varphi + 30°$		$\varphi 2 = 30° - \varphi$			

1. **RL-Load:**

S. No	Parameter to be measured	Wattmeter 1 P1=$V_L I_L \cos \varphi 1$	Wattmeter 2 P2=$V_L I_L \cos \varphi 1$	Real Power P=P1+P2	Reactive Power Q=$\sqrt{3}$(P2-P1)	Power Factor cosϕ= cos(tan^1(Q/P))
1	Voltage (RMS)	398.04 30	398.04 90	111801.58	130253.6	0.65(lag)
2	Current (RMS)	249.0 -49.36	383.01 120			
3	Phase Angle difference	79.36	-30			
4	Power	18299.78	93501.8			
	$\varphi 1 = \varphi + 30°$		$\varphi 2 = 30° - \varphi$			

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      --- AC Analysis ---

frequency:     50              Hz
V(van):        mag:         325 phase: 5.0106e-015°        voltage
V(vbn):        mag:         325 phase:       -120°         voltage
V(vcn):        mag:         325 phase:        120°         voltage
V(n001):       mag:     246.624 phase:    40.5561°         voltage
V(n003):       mag:     211.313 phase:   -169.362°         voltage
V(n002):       mag: 7.10543e-014 phase:    -126.87°        voltage
V(n004):       mag:     211.313 phase:    70.6379°         voltage
I(L3):         mag:     352.188 phase:   -109.362°         device_current
I(L2):         mag:     352.188 phase:    10.6379°         device_current
I(L1):         mag:     352.188 phase:   -49.3621°         device_current
I(R3):         mag:     352.188 phase:    70.6379°         device_current
I(R2):         mag:     352.188 phase:   -169.362°         device_current
I(R1):         mag:     352.188 phase:   -49.3621°         device_current
I(V3):         mag:     352.188 phase:   -109.362°         device_current
I(V2):         mag:     352.188 phase:    10.6379°         device_current
I(V1):         mag:     352.188 phase:    130.638°         device_current
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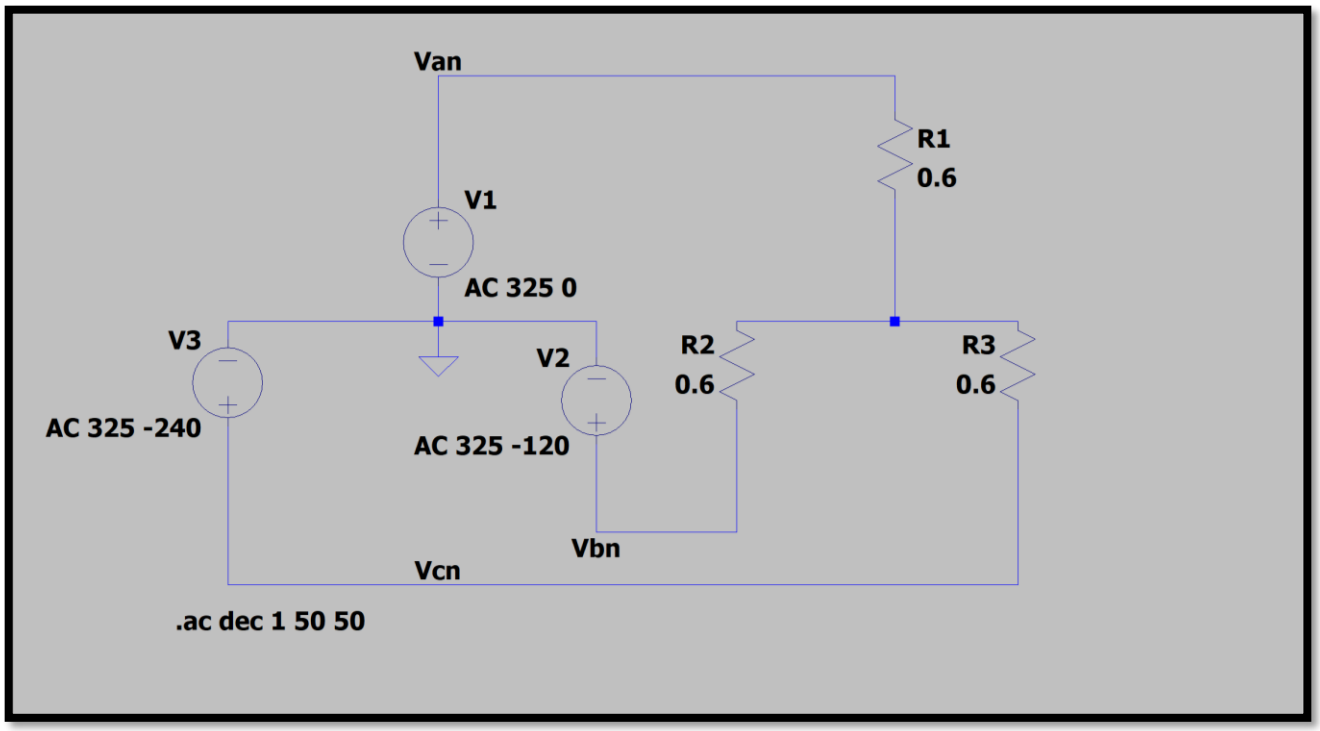


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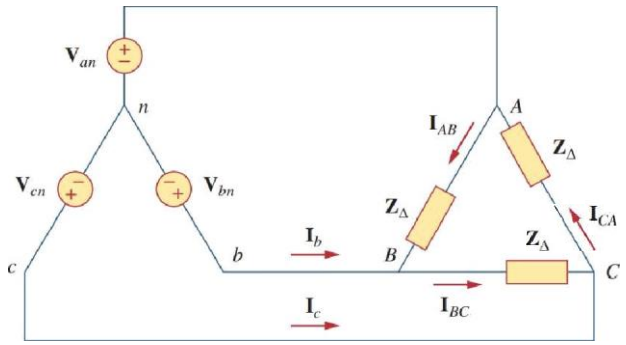
      --- AC Analysis ---

frequency:     50              Hz
V(van):        mag:         325 phase:          0°          voltage
V(vbn):        mag:         325 phase:       -120°          voltage
V(vcn):        mag:         325 phase:        120°          voltage
V(n001):       mag: 3.69482e-014 phase:    -112.62°        voltage
I(R3):         mag:     541.667 phase:        120°          device_current
I(R2):         mag:     541.667 phase:       -120°          device_current
I(R1):         mag:     541.667 phase: 6.01272e-015°        device_current
I(V3):         mag:     541.667 phase:        -60°          device_current
I(V2):         mag:     541.667 phase:         60°          device_current
I(V1):         mag:     541.667 phase:       -180°          device_current
```

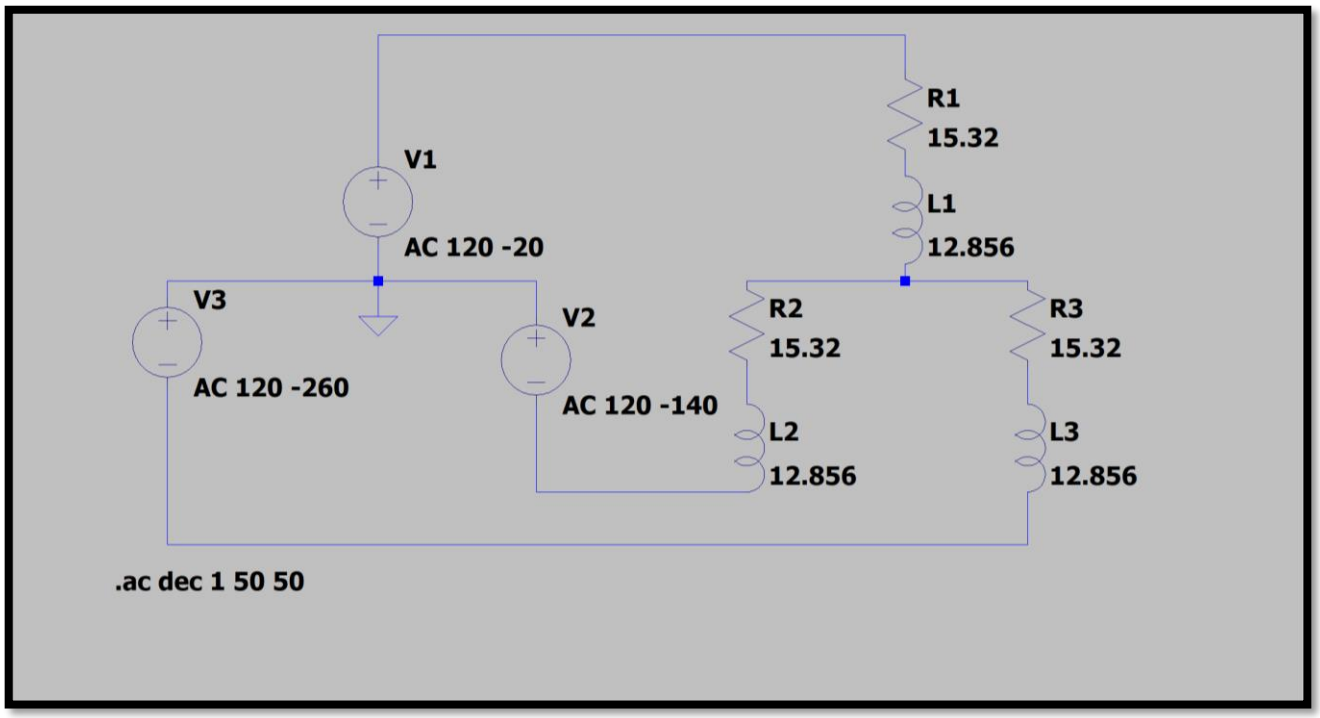
Do it yourself for practice:

a. Measure the rms values of all the above listed parameters using spice directive .MEAS
b. Measure the current through neutral wire



One line voltage of a balanced Y-connected source is V_{AB} = 120 -20 V, If the source is connected to a Δ-connected load of 20 40 Ω, find the phase and line currents. Assume the abc sequence.

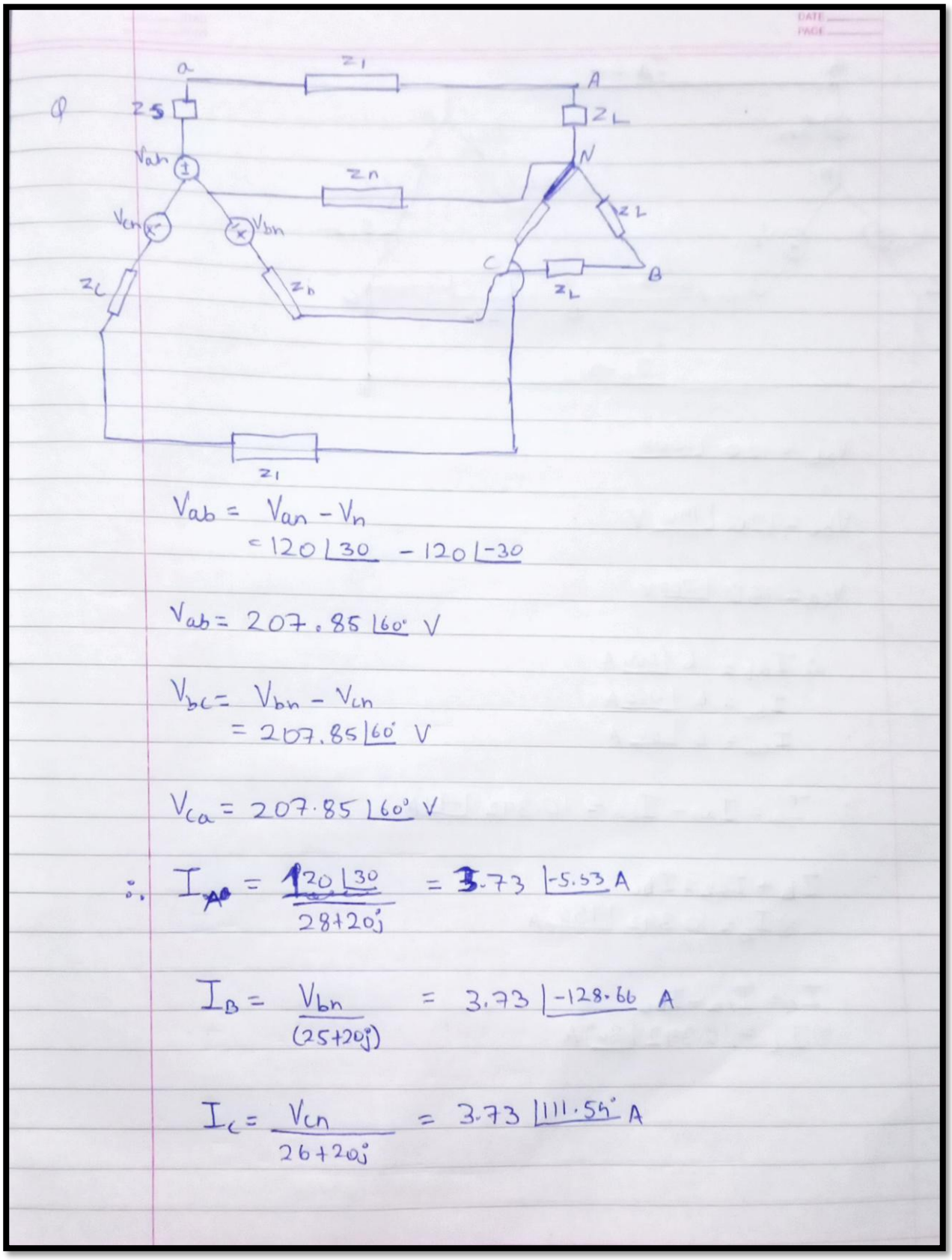
Answer: 6 -60A, 6 -180 A, 6 60 A, 10.392 -90 A, 10.392 150A, 10.392 30A.




```
      --- AC Analysis ---

frequency:     50              Hz
V(n001):       mag:         120 phase:         -20°         voltage
V(n006):       mag:         120 phase:          40°         voltage
V(n007):       mag:         120 phase:         -80°         voltage
V(n002):       mag:         120 phase:    -19.9276°         voltage
V(n003):       mag:          80 phase:         -20°         voltage
V(n004):       mag:     80.3939 phase:    -19.9449°         voltage
V(n005):       mag:     79.6056 phase:    -19.9465°         voltage
I(L3):         mag:   0.0262029 phase:     -30.676°         device_current
I(L2):         mag:   0.0262029 phase:     171.111°         device_current
I(L1):         mag: 0.00990378 phase:    -109.783°         device_current
I(R3):         mag:   0.0262029 phase:     -30.676°         device_current
I(R2):         mag:   0.0262029 phase:     171.111°         device_current
I(R1):         mag: 0.00990378 phase:    -109.783°         device_current
I(V3):         mag:   0.0262029 phase:     149.324°         device_current
I(V2):         mag:   0.0262029 phase:    -8.88926°         device_current
I(V1):         mag: 0.00990378 phase:     70.2173°         device_current
```

Calculations:



$$V_{ab} = V_{an} - V_n$$
$$= 120\angle 30 - 120\angle -30$$

$$V_{ab} = 207.85\angle 60^\circ \text{ V}$$

$$V_{bc} = V_{bn} - V_{cn}$$
$$= 207.85\angle 60^\circ \text{ V}$$

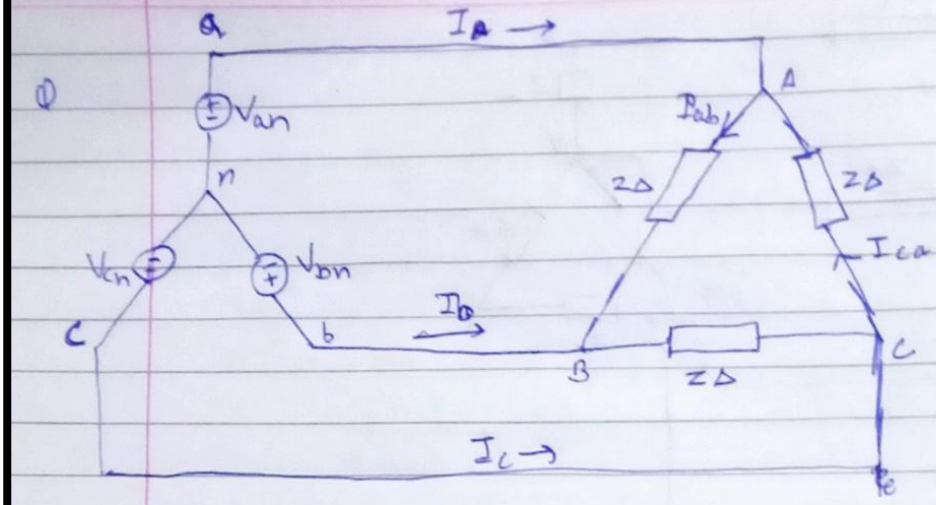
$$V_{ca} = 207.85\angle 60^\circ \text{ V}$$

$$\therefore I_{AA} = \frac{120\angle 30}{28+20j} = 3.73\angle -5.53 \text{ A}$$

$$I_B = \frac{V_{bn}}{(25+20j)} = 3.73\angle -128.66 \text{ A}$$

$$I_C = \frac{V_{cn}}{26+20j} = 3.73\angle 111.54^\circ \text{ A}$$

Q



$V_{ab} = 120 \angle -20° V$

$V_{bc} = 120 \angle 140 V$

$V_{ca} = 180 \angle -260° V$

$\therefore I_{ab} = 6 \angle -60 A$

$I_{bc} = 6 \angle -180 A$

$I_{ca} = 6 \angle 60 A$

$\therefore I_a = I_{ab} - I_{ba} = 10.392 \angle -90 A$

$I_B + I_{ab} = I_{bc}$

$\Rightarrow I_b = 10.392 \angle 180° A$

$I_C = I_{ca} - I_{bc}$

$\Rightarrow I_c = 10.392 \angle 30° A$