ROHINI COLLEGE OF ENGINEERING AND TECHNOLOGY

Anjugrammam main Road, Palkulam 629401, Kanyakumari District

Department of Electrical and Electronics Engineering

Academic Year (2023-24) (EVEN)

EE3401 – TRANSMISSION AND DISTRIBUTION

ASSIGNMENT RUBRICS

KNOWLEDGE DOMAIN RUBRICS (EE3401)	Marks
Assignment questions have been answered/solved appropriately and submitted on-time.	4
Presentation and sequence representation of the assigned work.	3
Perceptional view over the assigned work reflecting self-learning aspect.	3
TOTAL	10

ROHINI COLLEGE OF ENGINEERING & TECHNOLOGY, PALKULAM

Accredited by NAAC with A+ Grade

Department of Electrical and Electronics Engineering

TRANSMISSION AND DISTRIBUTION

<EE3401>

Assignment – 2

S. No.	Assignment Questions	K Level	CO	Mapping of PO/PSO
1	Explain the short transmission line with a neat circuit and phasor diagram.	K2	21C211.2	PO1, PO12, PSO1
2	Outline the medium 'T' transmission line with a neat circuit and phasor diagram.	K2	21C211.2	PO1, PO12, PSO1
3	Outline the medium Π transmission line with a neat circuit and phasor diagram.	K2	21C211.2	PO1, PO12, PSO1
4	Infer the rigorous method of long transmission line with a neat circuit.	K2	21C211.2	PO1, PO12, PSO1
5	Infer the receiving end and sending end power circle diagram with neat sketches and procedures.	K2	21C211.2	PO1, PO12, PSO1

Submitted By: M. Deepshika

IInd yr EEE

Roll No: 12 / Reg. No. 13

10/10

4+3+3

Assignment Date: 29.02.2024

Submission Date : 08-04-24

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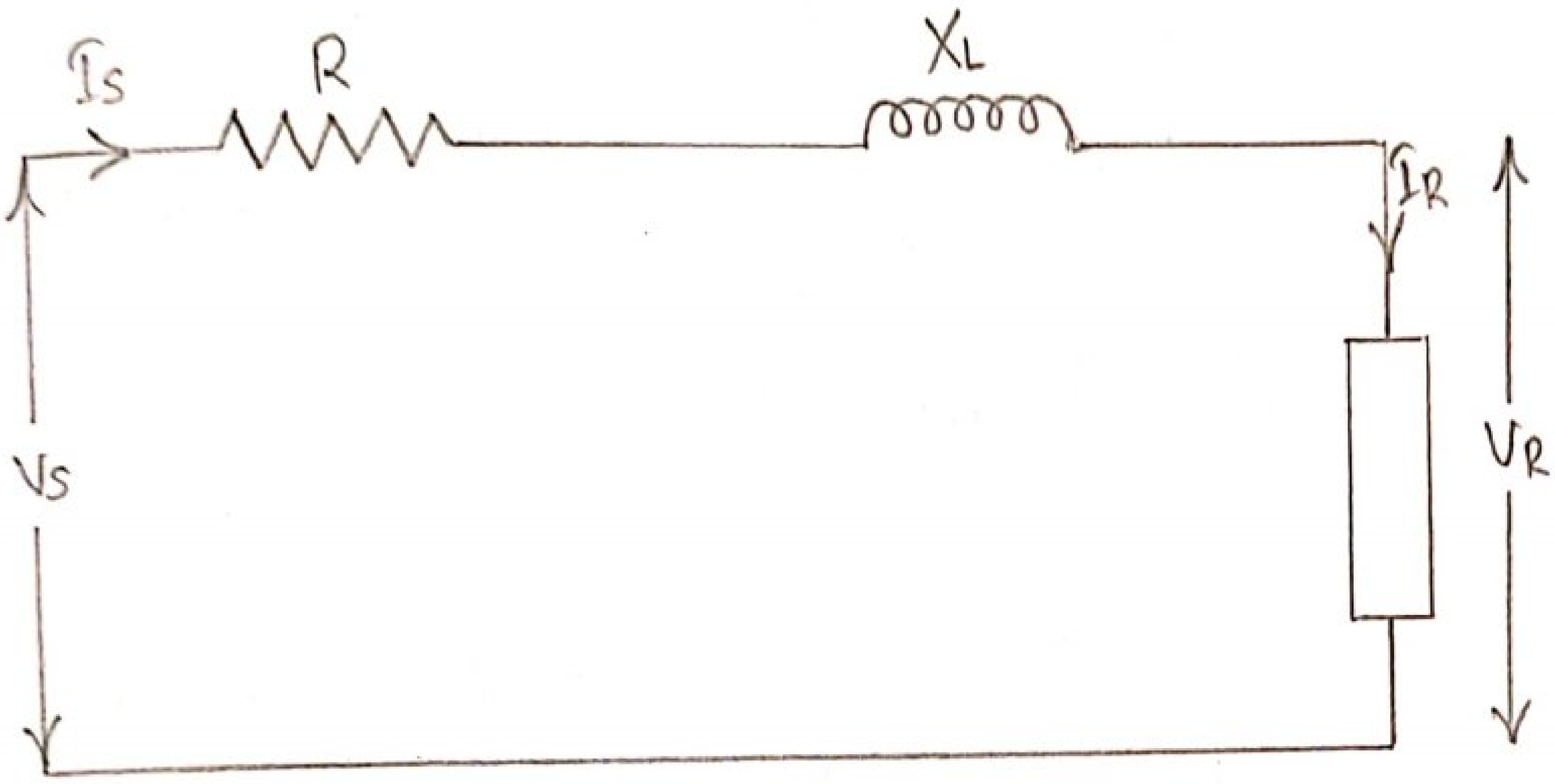
Explain the short transmission line with a neat circuit and phasor diagram.

(*) Voltage is less than 20 kvolt

(*) Line length is upto 50 km

(*) Capacitance neglected.



Let, $I_R \Rightarrow I$ load current

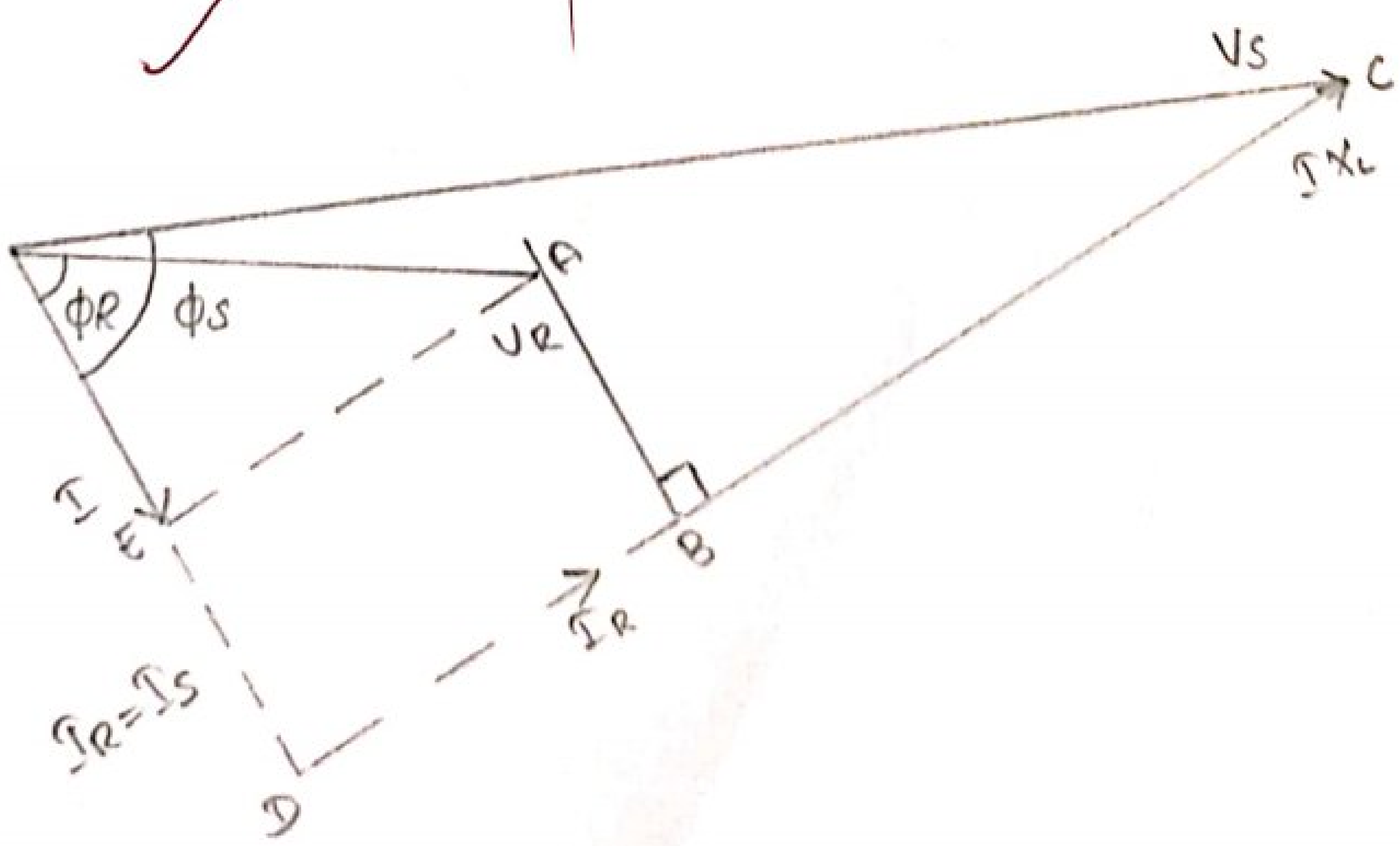
$R \Rightarrow$ loop resistance

$X_L \Rightarrow$ loop reactance

$V_S \Rightarrow$ Sending end voltage

$V_R \Rightarrow$ ~~Sending~~ Receiving end voltage

Phasor Diagram:



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From the right angle triangle

ΔODC

$$OC^2 = OD^2 + DC^2$$

$$= (OE + DE)^2 + (OB + BC)^2$$

$$V_S^2 = (V_R \cos\phi_R + I_R)^2 + (V_R \sin\phi_R + I X_L)^2$$

$$V_S = \sqrt{(V_R \cos\phi_R + I_R)^2 + (V_R \sin\phi_R + I X_L)^2}$$

(1) % voltage Regulation $= \frac{V_S - V_R}{V_R} \times 100\%$

$$= \frac{I_R R \cos\phi_R \pm I_R \sin\phi_R}{E_R} \times 100$$

(2) Transmission Efficiency $= \frac{V_R I_R \cos\phi_R}{V_S I_S \cos\phi_S}$

$$\% \text{ Tr. eff} = \frac{V_R I_R \cos\phi_R}{V_R I_R \cos\phi_R + I^2 R} \times 100$$

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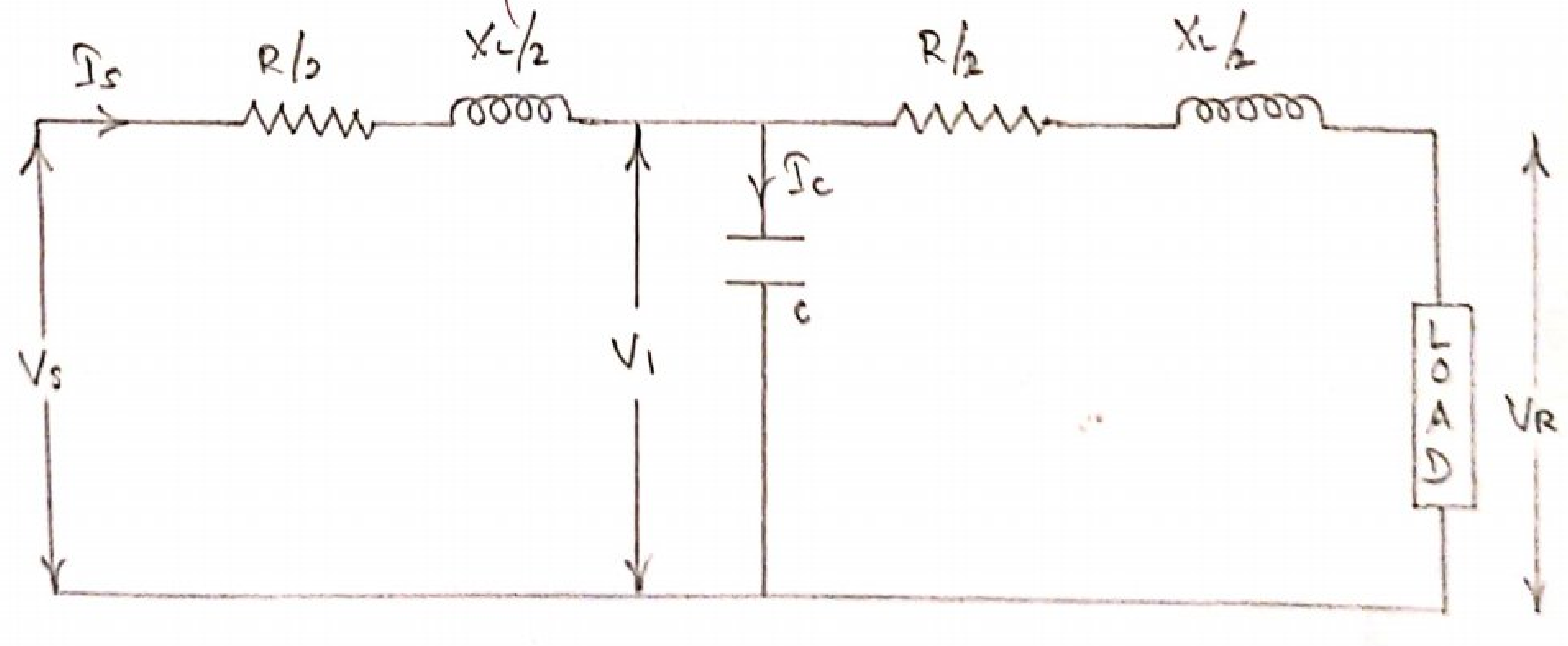
2. Explain the medium T transmission line with neat diagram and phasor diagram.



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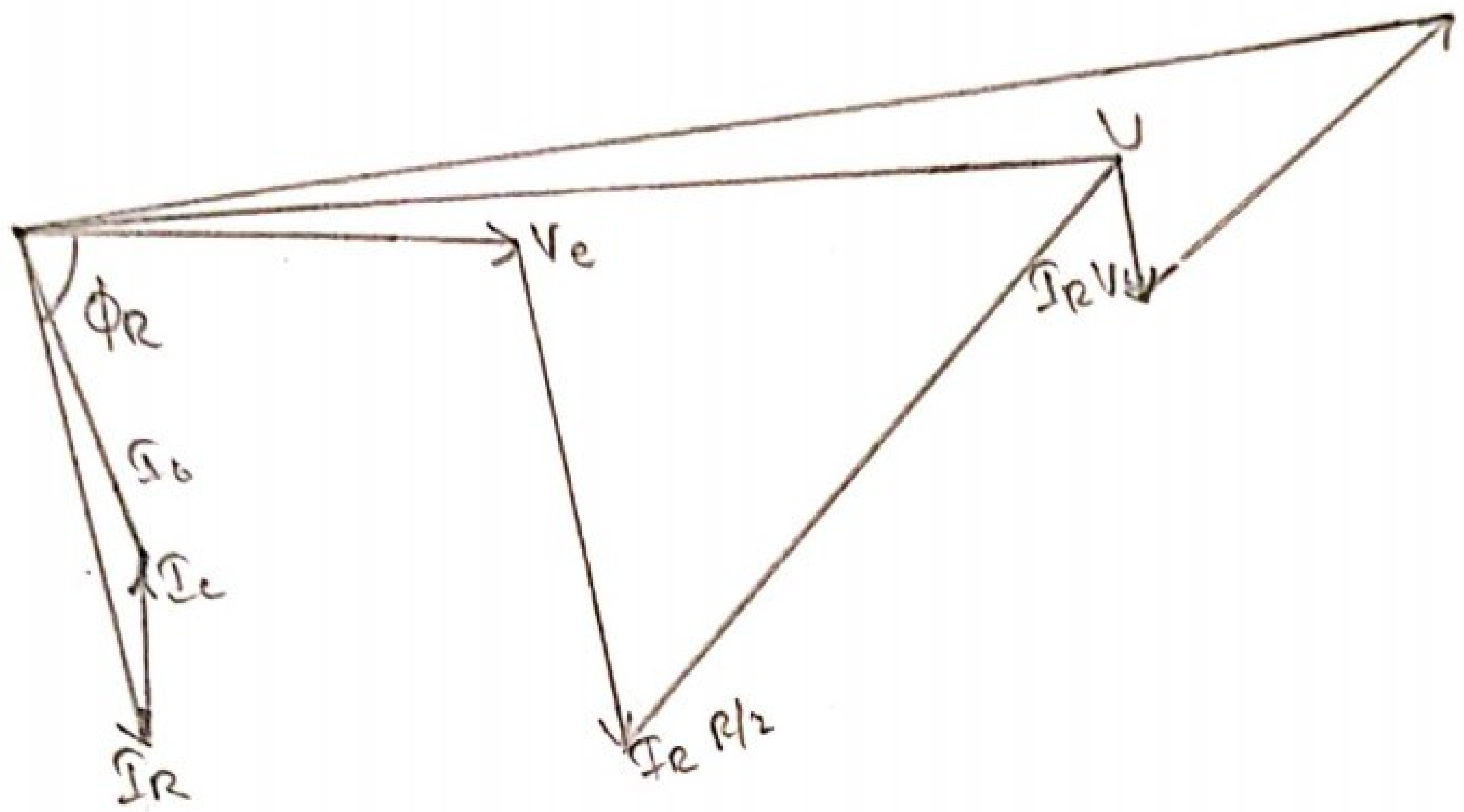
Let, V_R ⇒ receiving end voltage

I_R ⇒ load current

R ⇒ loop resistance

X_L ⇒ loop reactance

Phasor Diagram:



$$V_R = V_R\,(1+j0)$$

$$\vec{I_R} = I_R(\cos\phi_R - j\sin\phi_R)$$

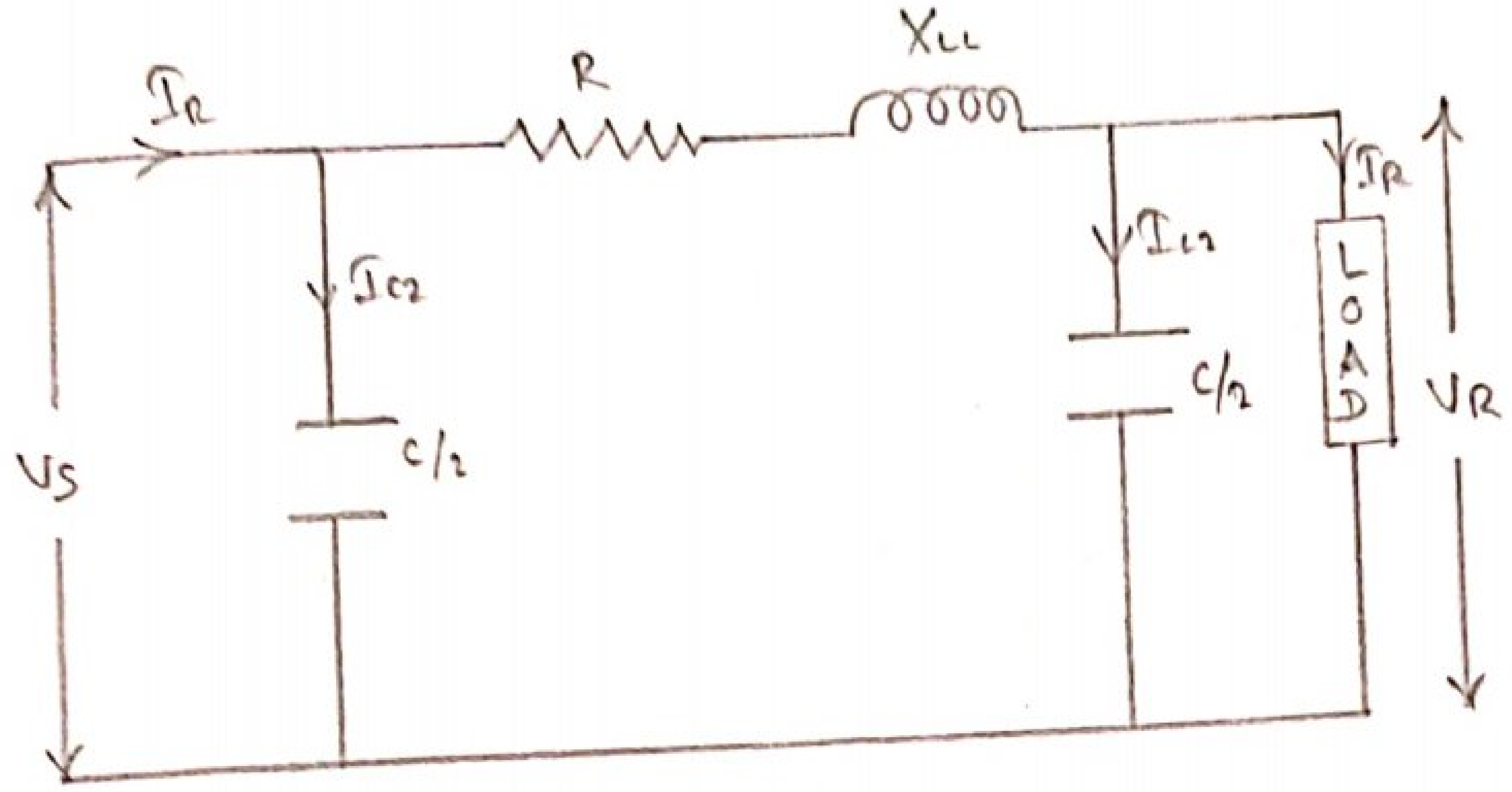
$$\vec{I_C} = j\omega C\,\vec{V_1} = j2\pi f C\vec{V_1}$$

$$\vec{V_1} = \vec{V_R} + \vec{I_R}\,(R/2 + jX_L/2)$$

$$\vec{I_S} = \vec{I_R} + \vec{I_C}$$

$$\vec{V_S} = \vec{V_1} + \vec{I_S}\,(R/2 + jX_L/2)$$

Explain the medium π method with neat diagram and phasor diagram :



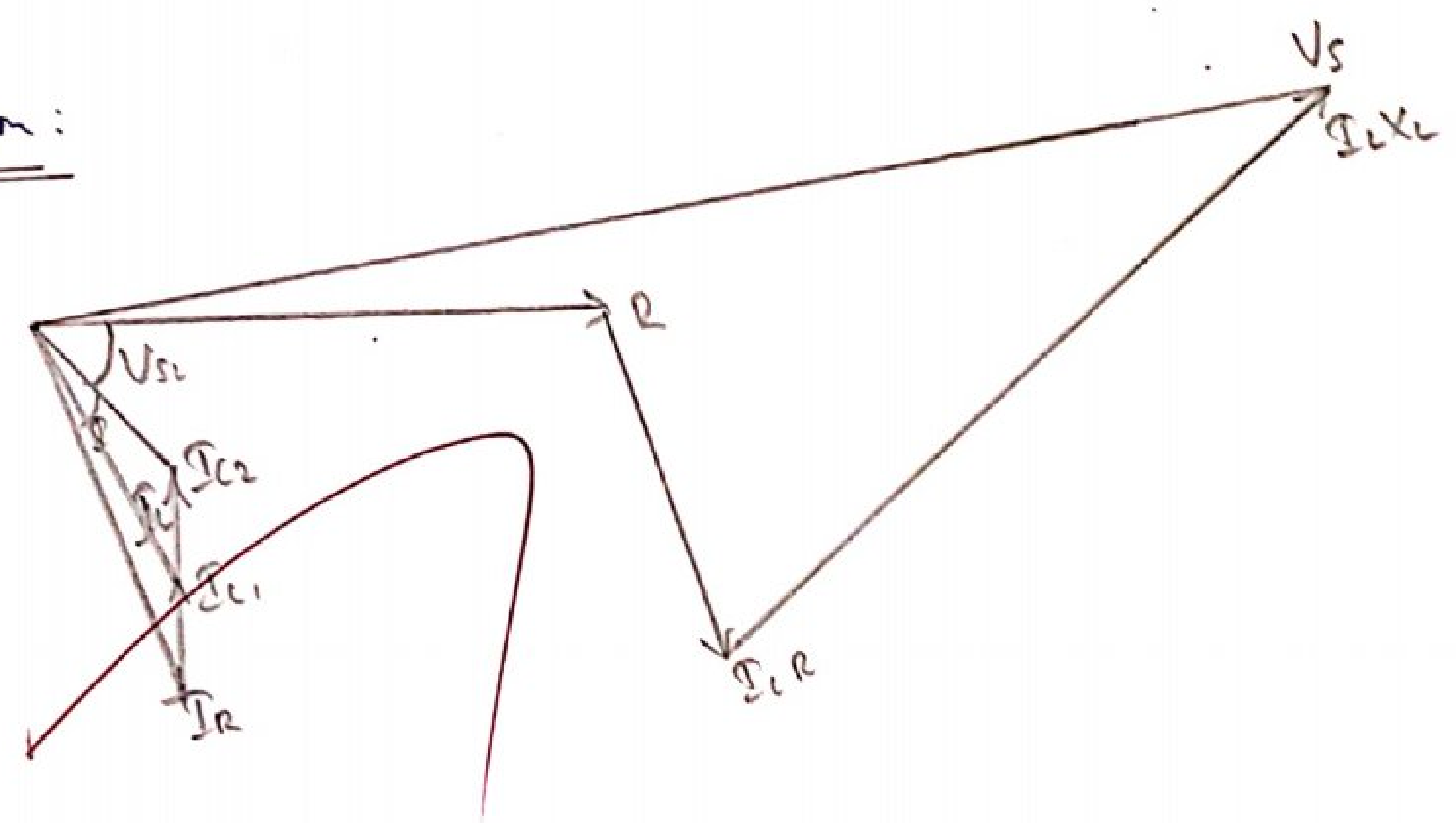
Let, $V_R \Rightarrow$ Receiving end voltage

$I_R \Rightarrow$ load current

$R \Rightarrow$ Loop resistance

$X_L \Rightarrow$ Loop reactance

Phasor Diagram :



$\vec{V_R} = \vec{V_R}\ (1+j0)$

$\vec{I_R} = I_R\ (\cos\phi - j \sin\phi_R)$

$\vec{I_{C1}} = j\omega\ C/2\ \vec{V_R} = j 2\pi f C/2\ \vec{V_R}$

$\vec{I_{CB}} = j 2\pi\ f\ C/2\ \vec{V}_{-1}$

$\vec{V_S} = \vec{V_R} + \vec{I_L}\ (R + jX_L)$

$\vec{V_S} = \vec{V_R} + \vec{I_C}\ (R + jX_L)$

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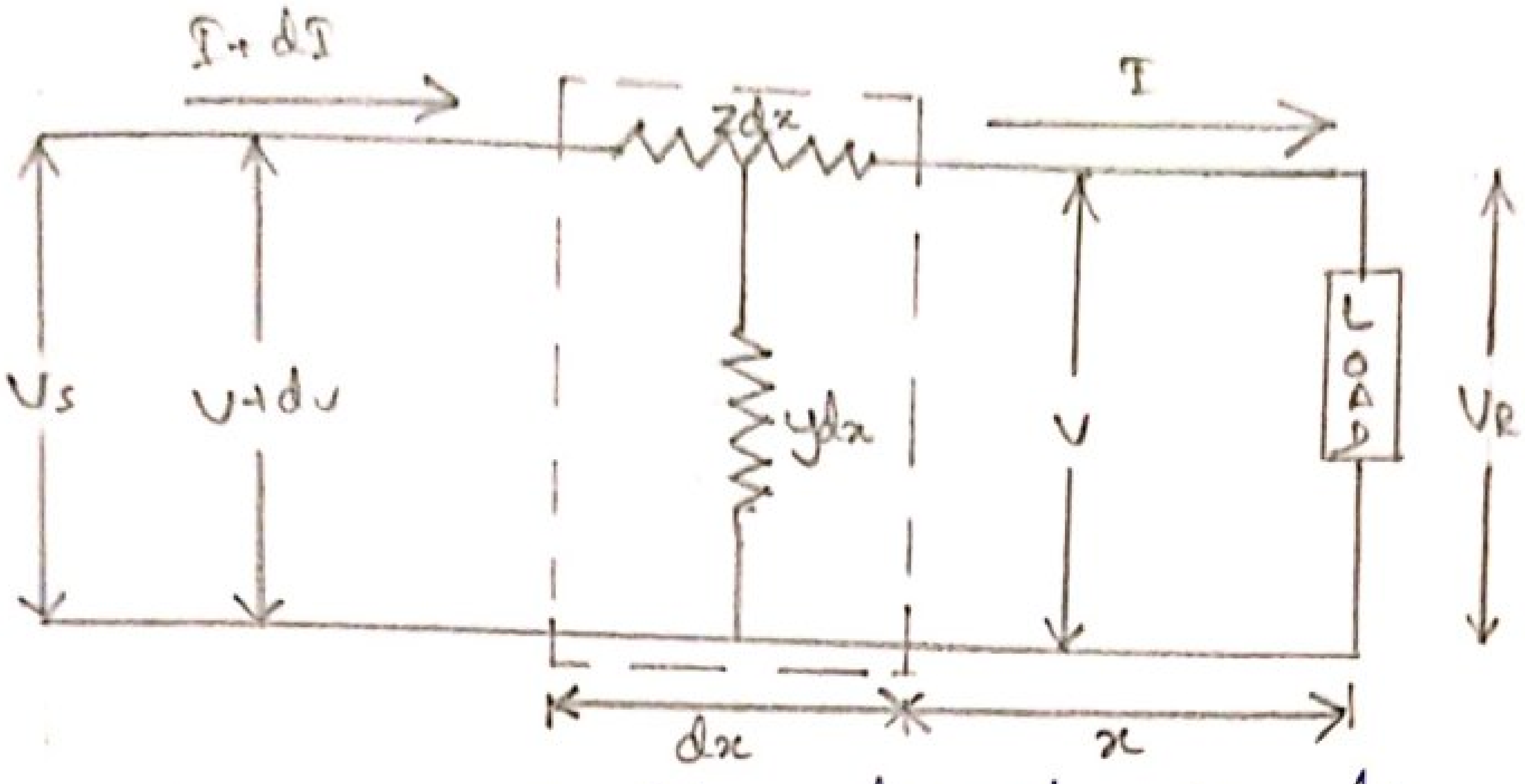
Explain the long transmission line (Rigorous method) with neat diagram.



Consider a small element in line length of is 2 'dx' situated at the distance x from the receiving end.

$$dV = Iz\,dx$$

$$\frac{dV}{dx} = Iz \quad \text{———} \; ①$$

$$dI = Vy\,dx$$

$$\frac{dI}{dx} = Vy \quad \text{———} \; ②$$

differentiating equation, ①

$$\frac{d^2V}{dx^2} = z\frac{dI}{dx}$$

$$\frac{d^2V}{dx^2} = zyx \quad (\text{from } ②)$$

$$\frac{d^2V}{dx^2} - zy\cancel{V} = 0$$

Solution is,

$$V = k_1 \cosh(x\sqrt{yz}) + k_2 \sinh(x\sqrt{yz}) \quad \text{———} \; ③$$

differentiate equation ③

$$\frac{dV}{dx} = k_1\sqrt{yz}\,\sinh(x\sqrt{yz}) + k_2\sqrt{yz}\,\cosh(x\sqrt{yz})$$

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from ①

$$I_? = k_1 \sqrt{y_2} \sinh(x\sqrt{y_2}) + k_2 \sqrt{y_2} \cosh(x\sqrt{y_2})$$

$$I = k_1 \frac{\sqrt{y_2}}{z} \sinh(x\sqrt{yz}) + k_2 \frac{\sqrt{yz}}{z} \cosh(x\sqrt{yz})$$

$$I = k_1 \sqrt{\frac{y}{z}} \sinh(x\sqrt{yz}) + k_2 \sqrt{\frac{y}{z}} \cosh(x\sqrt{yz}) \quad \text{—— ④}$$

To find k_1 and k_2

where, $x=0$, $V=V_R$, $I=I_R$

Sub in eqnt. ③ and ④

$$③ \Rightarrow V_R = k_1$$

$$④ \Rightarrow I_R = k_2\sqrt{\frac{y}{z}} \Rightarrow k_2 = I_R\sqrt{\frac{z}{y}}$$

$$③ \Rightarrow V = V_R \cosh(x\sqrt{yz}) + I_R\sqrt{\frac{z}{y}} \sinh(x\sqrt{yz}) \quad \text{—— ⑤}$$

$$④ \Rightarrow I = V_R\sqrt{\frac{y}{z}} \sinh(x\sqrt{yz}) + I_R \cosh(x\sqrt{yz})$$

when,

$V=V_S$, $I=I_S$, $x=1$

$$⑤ \Rightarrow V_S = V_R \cosh(1\sqrt{yz}) + I_R\sqrt{\frac{z}{y}} \sinh(1\sqrt{yz})$$

$$⑥ \Rightarrow I_S = V_R\sqrt{\frac{y}{z}} \sinh(1\sqrt{yz}) + I_R \cosh(1\sqrt{yz})$$

let

$X = xl$, $Y = yl$, $Z = zl$

$$V_S = V_R \cosh\sqrt{YZ} + I_R\sqrt{\frac{Z}{Y}} \sinh\sqrt{YZ}$$

$$I_S = V_R\sqrt{\frac{Z}{Y}} \sinh\sqrt{YZ} + I_R \cosh\sqrt{YZ}$$

Refer the receiving end and sending end power cycle diagram with neat sketche and procedure.

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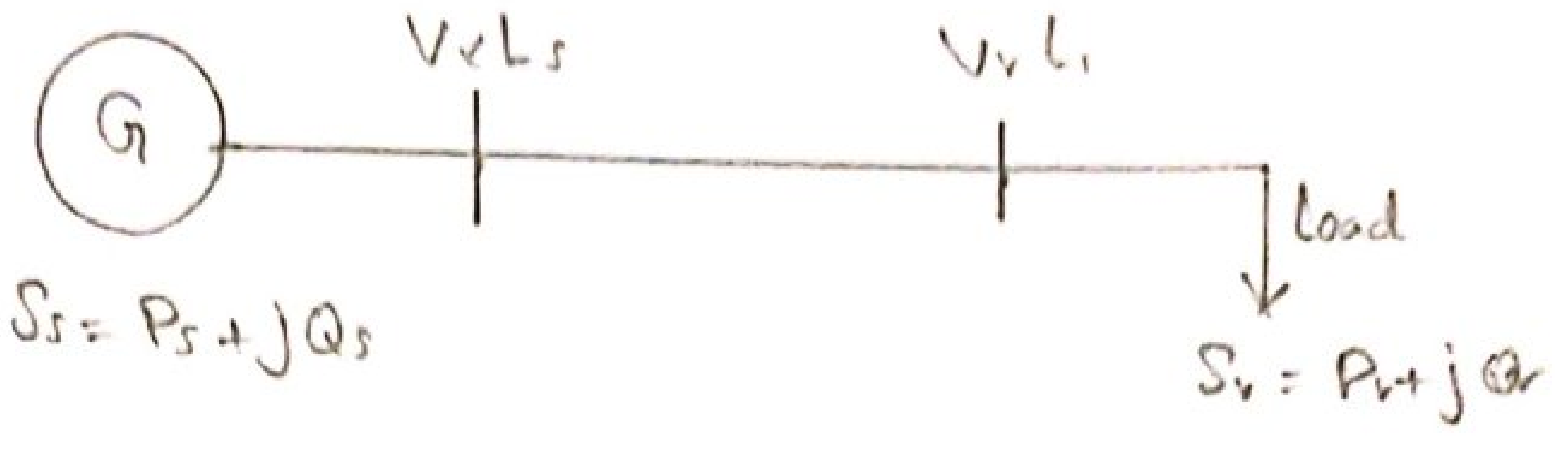

let,

V_s, V_R = Sending and Receiving end voltage

I_s, I_R = Sending and Receiving end current

P_s, P_r = Sending and Receiving end real power

Q_s, Q_r = sending and Receiving end reactive power

$$\vec{V_s} = \vec{A} V_R + \vec{B} \vec{I_R} \quad \text{——— (1)}$$

$$\vec{I_s} = \vec{C} V_R + \vec{D} I_r \quad \text{——— (2)}$$

Take, $\vec{A} = |A| \angle \alpha$, $\vec{B} = |B| \angle \phi$, $\vec{D} = |D| \angle \alpha$

$\vec{V_s} = |V_s| \angle \delta$, $\vec{V_r}\ |V_r| \angle 0$

$$(1) \Rightarrow \vec{I_r} = \frac{|V_s|}{|B|} \angle \delta - \phi - \frac{|A| |V_r|}{|B|} \angle \alpha - \phi$$

$$\vec{I_r} = \frac{|V_s|}{|B|} \angle \phi - \delta - \frac{|A| |V_r|}{|B|} \angle \phi - \alpha \quad \text{——— (3)}$$

$$\vec{V_r} = \vec{D} \vec{V_s} - \vec{B} \vec{I_s} \quad \text{——— (4)}$$

$$\vec{I_r} = -\vec{C_s} \vec{V_s} + \vec{A} \vec{I_s} \quad \text{——— (5)}$$

$$(4) \Rightarrow \vec{I_s} = \frac{|D| |V_s|}{|B|} \angle \alpha + \delta - \phi - \frac{|V_r|}{|B|} \angle -\alpha$$

$$\vec{I_s}^{*} = \frac{|D| |V_s|}{|B|} \angle \alpha - \alpha - \delta - \frac{|V_r|}{|B|} \angle \alpha \quad \text{——— (6)}$$

Complete power phase pase at sending end

$$S_s = P_s + jQ_s$$

$$S_s = \frac{|D| |V_s^2|}{|B|} \angle \phi - \alpha - \frac{|V_s| |V_r|}{|B|} \angle \alpha - \delta \quad \text{——— (7)}$$

Receiving EhQ :

$$S_r = \frac{|V_s||V_r|}{|B|}\angle \phi - \delta - \frac{|A||V_r^2|}{|B|}\angle \phi - \alpha \quad \text{--- (8)}$$

Real and reactive power

(7) $\Rightarrow$ $S_s + P_s + jQ_s$

$$P_s = \frac{|D||V_s^2|}{|B|}\cos(\phi - \alpha) - \frac{|V_s|V_r}{|B|}\cos(\phi - \delta) \quad \text{--- (9)}$$

$$Q_s = \frac{|D||V_s^2|}{|B|}\sin(\phi - \alpha) - \frac{|V_s|V_s}{|B|}(\sin \phi + \delta) \quad \text{--- (10)}$$

(8) $\Rightarrow$ $S_r = P_r + jQ_r$

$$P_r = \frac{|V_s||V_r|}{|B|}\cos(\phi - \delta) - \frac{|A||V_r^2|}{|B|}\cos(\phi - \alpha) \quad \text{--- (11)}$$

$$Q_r = \frac{|V_s||V_r|}{|B|}\sin(\phi - \delta) - \frac{|A||V_r^2|}{|B|}\sin(\phi - \alpha) \quad \text{--- (12)}$$

Power circle diagram :

$$\left[P_r + \frac{|A||V_r^2|}{|B|}\cos(\phi - \alpha)\right] = \left[\frac{|V_s||V_r|\cos(\phi - \delta)}{|B|}\right] \quad \text{--- (13)}$$

$$\left[Q_r + \frac{|A||V_r^2|}{|B|}\sin(\phi - \alpha)\right] = \left[\frac{|V_s||V_r|}{|B|}\sin(\phi - \alpha)\right] \quad \text{--- (14)}$$

Square and add (13), (14)

$$\left[P_r + \frac{|A||V_r^2|}{|B|}\cos(\phi - \alpha)\right]^2 + \left[Q_r + \frac{|A||V_r^2|}{|B|}\sin(\phi - \alpha)\right]^2$$
$$= \left[\frac{|V_s||V_r|}{|B|}\cos(\phi - \alpha)\right]^2 + \left[\frac{|V_s||V_r|}{|B|}\sin(\phi - \alpha)\right]^2$$

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$$= \left| \frac{|V_s||V_r|}{|B|} \right|^2$$

This is a circle equation with centre point

$$X_c = \frac{|A| \, |V_r^2|}{|B|} \cos(\phi - \alpha)$$

$$Y_c = -\frac{|A| \, |V_r^2|}{|B|} \sin(\phi - \alpha)$$

$$r = \frac{|V_s| \, |V_r|}{|B|}$$

Procedure :

(*) Locate the centre of the circle O, on the x, y plain.

(*) With radius $\left(\frac{|V_s||V_r|}{|B|} \right)$, draw an arc of circle from O.

(*) With an angle ϕ_r draw a line from the origin which intersects the circle at M.

(*) Draw a perpendicular line at x-axis at N which centre sets the circle point M.

(*) From the centre of circle (O_1) draw a line parallel to x-axis line which intersects the circle at O and also the verticle axis at l.

S, C represent the maximum power.

(*) Draw a line between O_1 and O at angle $(\phi - \alpha)$

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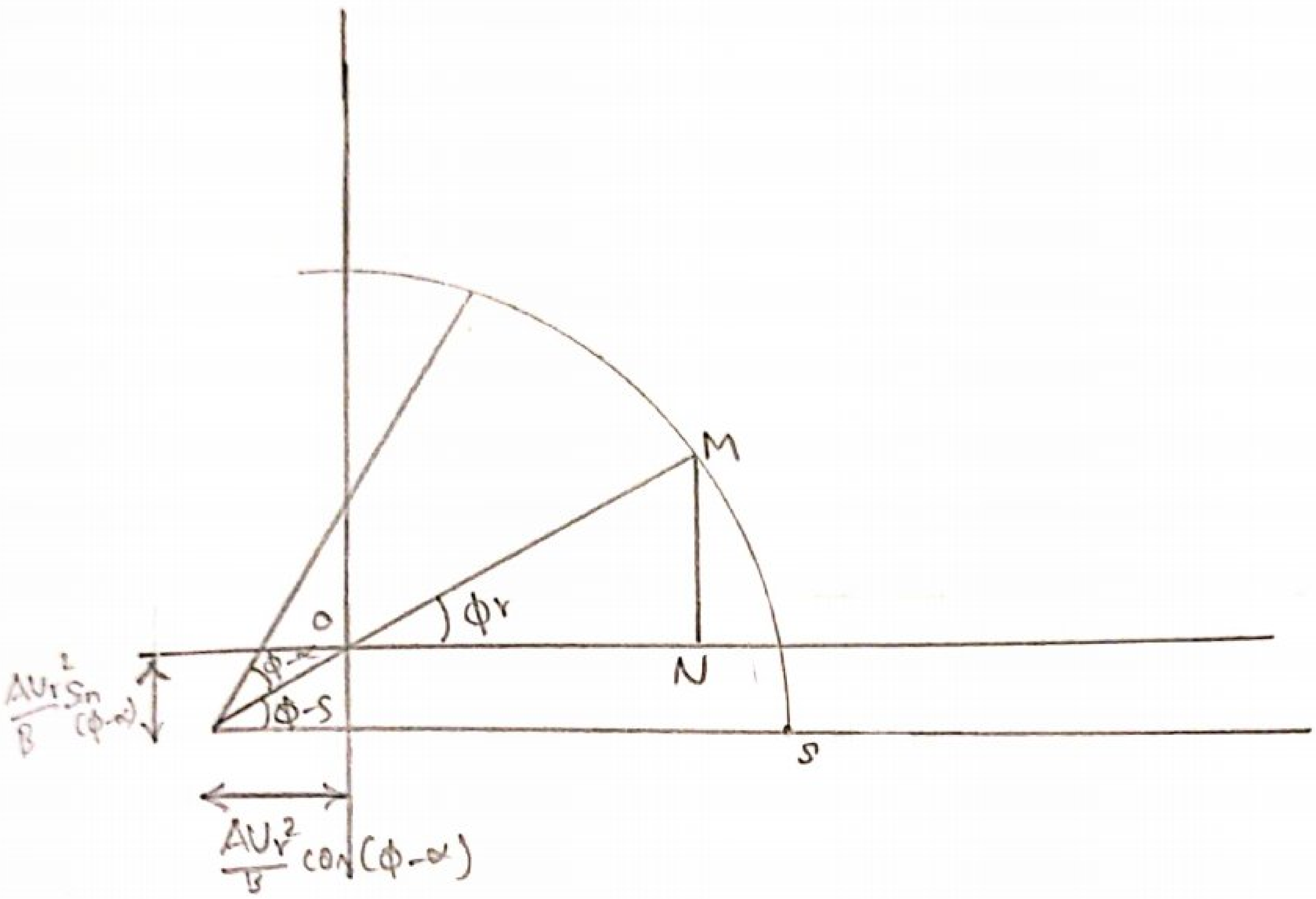
(*) Draw a line from O, to M and with angle is $(\phi - \alpha)$



Sending end power cycle diagram :

(*) Locate the centre of circle O, and x, y plane.

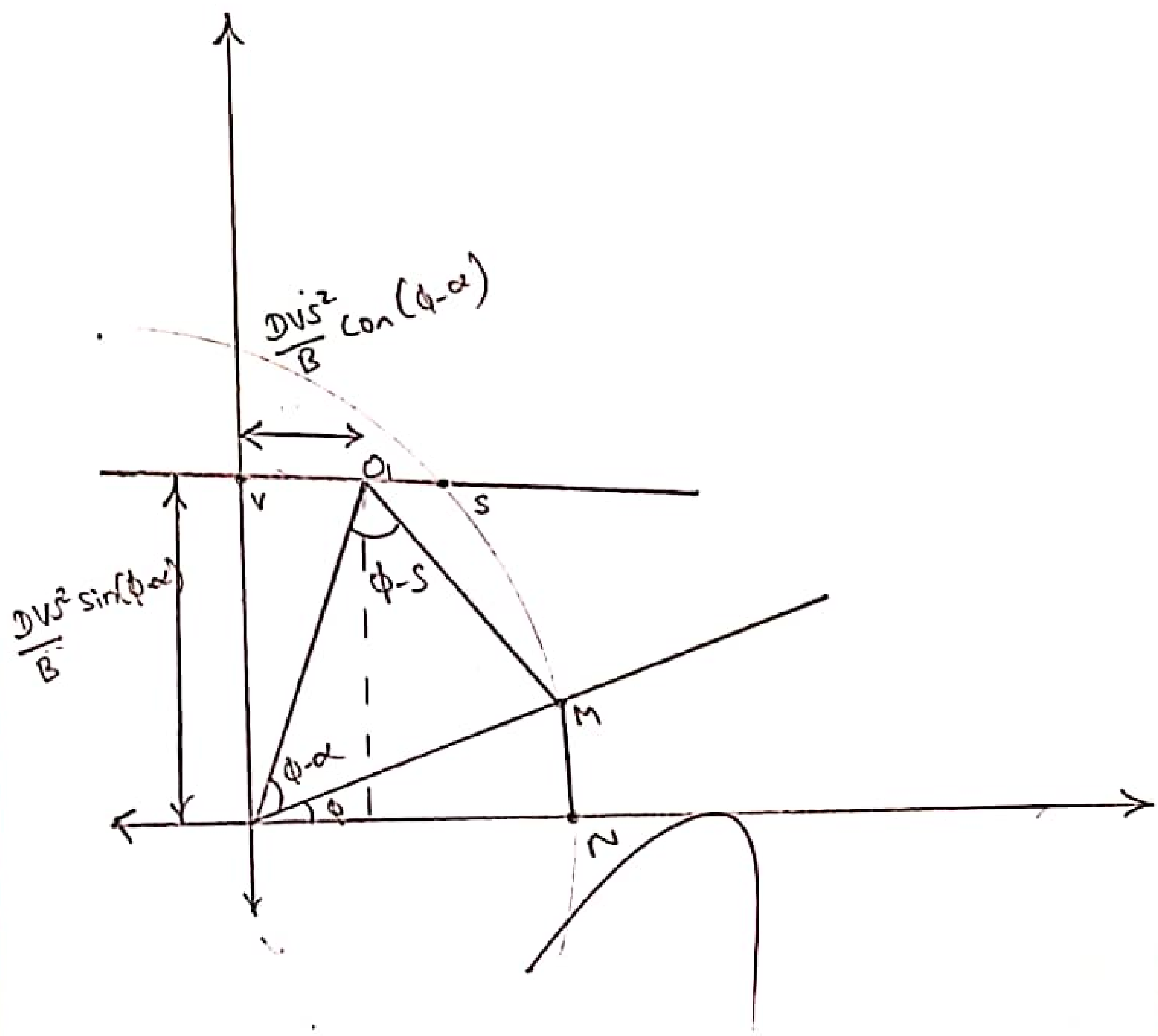
(*) With radius $\frac{V_s V_r}{B}$, draw an area of circle from O,

(*) With an angle of ϕ_r, draw a line from orgin which internets the circle at M.

(*) Draw a line perpendicular to x axis which cuts in N.

M, N reactive power, ON real are active power.

(*) From O, draw a line horizontal to x-axis.



$\frac{DVs^2}{B}\cos(\phi-\alpha)$
O_1
V
S
$\frac{DVs^2}{B}\sin(\phi-\alpha)$
$\phi-S$
M
$\phi-\alpha$
ϕ
N