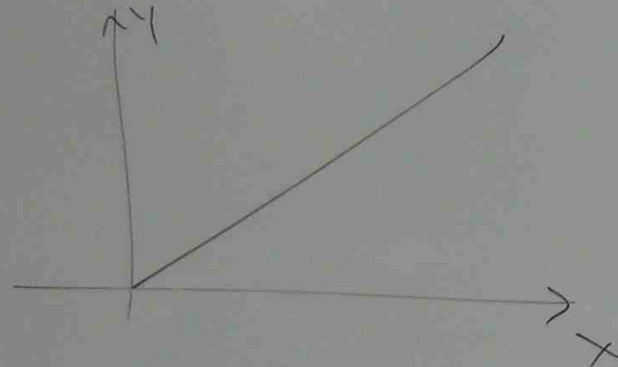
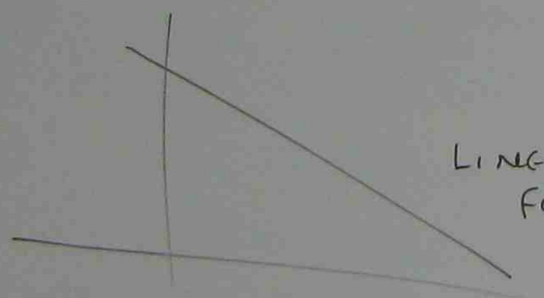
G047 — POWER ENGINEERING MATHEMATICS

LINEAR / NON LINEAR AND EXPONENTIAL FUNCTIONS

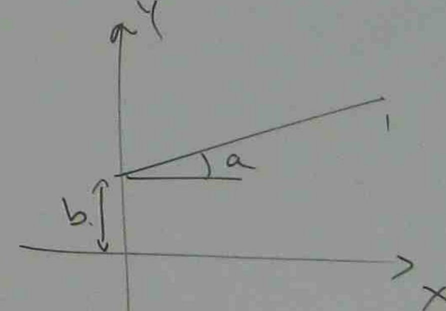
LINEAR





LINEAR FUNCTION

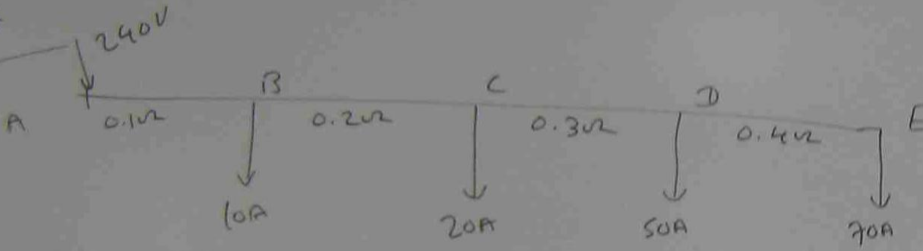
VOLTAGE DROP IN TRANSMISSION LINE IS LINEAR FUNCTION



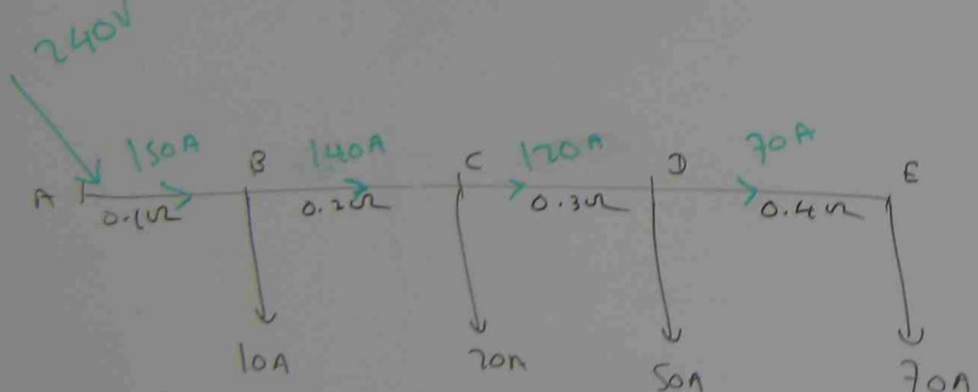
$$\boxed{Y = aX + b}$$

MATHEMATICAL EQUATION FOR LINEAR FUNCTION

Ex



FIND THE LOAD VOLTAGES AT A, B, C, D, E FOR GIVEN POWER LINE.



$$V_B = V_A - I_{AB} \times R_{AB}$$

$$= 240 - 150 \times 0.1$$

$$= 240 - 15 = 225\,V$$

$$V_C = V_B - I_{BC} \times R_{BC}$$

$$= 225 - 140 \times 0.2$$

$$= 225 - 28$$

$$= 197\,V$$

$$V_D = V_C - I_{CD} \times R_{CD}$$

$$= 197 - 120 \times 0.3$$

$$= 197 - 36$$

$$= 161\,V$$

$$V_E = V_D - I_{DE} \times R_{DE}$$

$$= 161 - 70 \times 0.4$$

$$= 161 - 28$$

$$= 133\,V$$

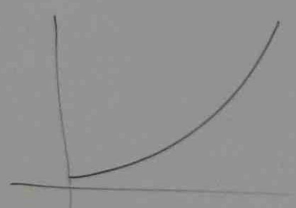
FIND LINE EFFICIENCY

LINE OUTPUT POWER $= V_B I_B + V_C I_C + V_D I_D + V_E I_E$

$= 225 \times 10 + 197 \times 20 + 161 \times 50 + 133 \times 70$

$= 23550$ WATT.

LINE POWER LOSS $= \sum I^2 R$



NON LINEAR FUNCTION

TOTAL POWER LOSS $= I_{AB}^2 R_{AB} + I_{BC}^2 R_{BC} + I_{CD}^2 R_{CD} + I_{DE}^2 R_{DE}$

TOTAL POWER LOSS $= (150)^2 \times 0.1 + (140)^2 \times 0.2 + (120)^2 \times 0.3 + (70)^2 \times 0$

$= 12450$ WATT.

TOTAL INPUT POWER $=$ TOTAL POWER LOSS $+$ LINE OUTPUT POWER

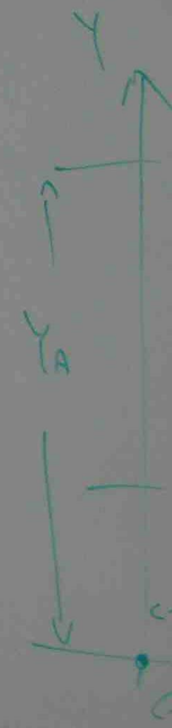
$= 12450 + 23550$

$= 36000$ WATT

LINE EFFICIENCY $= \dfrac{\text{LINE OUTPUT POWER}}{\text{LINE INPUT POWER}} \times 100$

$= \dfrac{23550}{36000} \times 100$

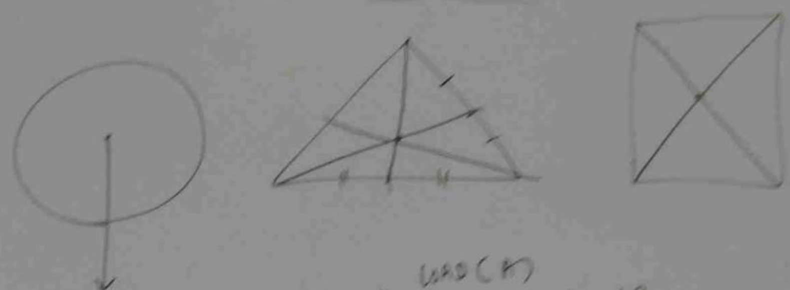
$= 65.4\ \%$

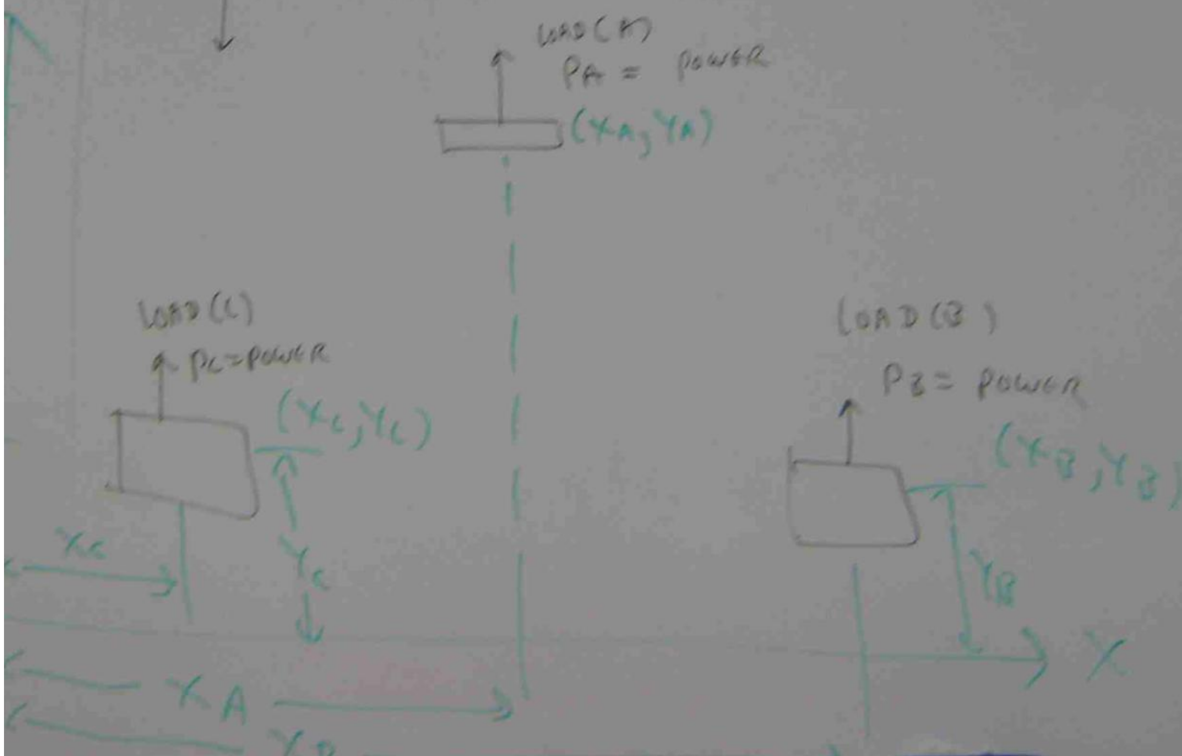


$^2 \times 0.4$

APPLICATION OF LINEAR FUNCTION IN POWER SYSTEM DESIGN

<LOAD CENTRE>

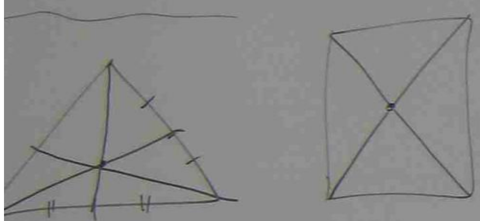




LINEAR FUNCTION IN

DESIGN

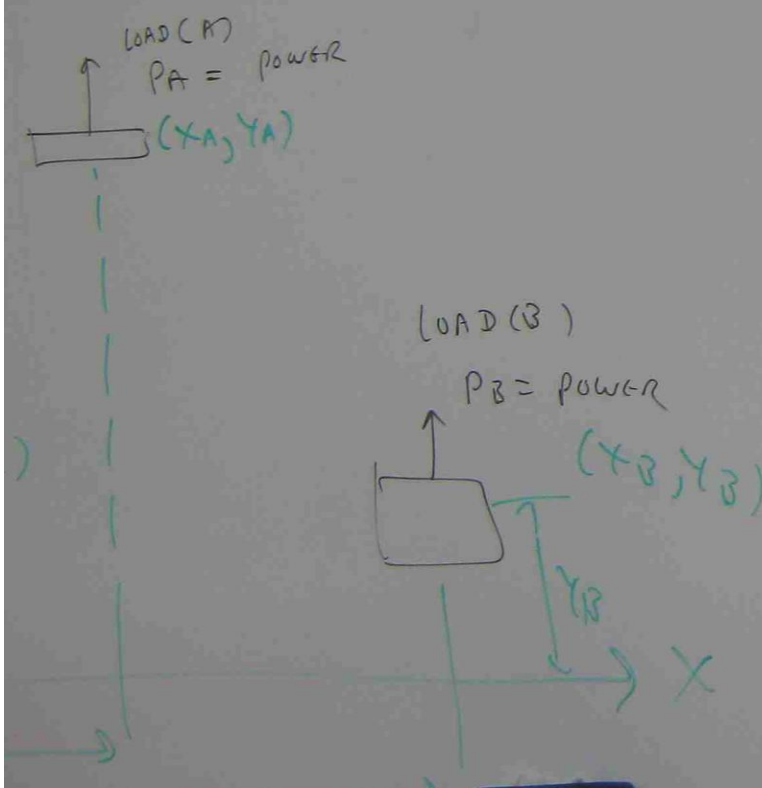
CENTRE



LOCATION OF POWER STATION

$$\bar{X} = \frac{P_A X_A + P_B X_B + P_C X_C}{P_A + P_B + P_C}$$

$$\bar{Y} = \frac{P_A Y_A + P_B Y_B + P_C Y_C}{P_A + P_B + P_C}$$

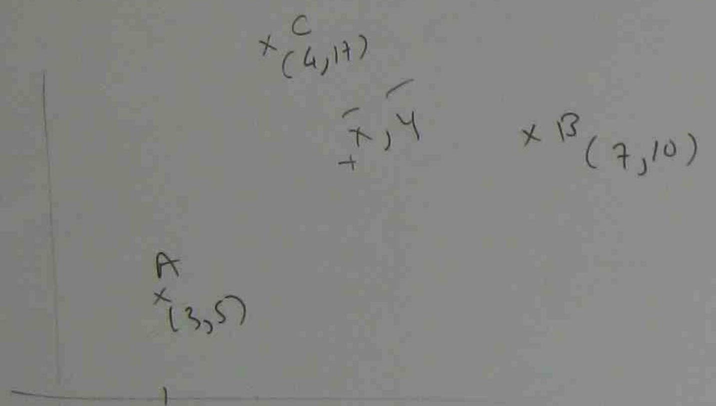


Ex 3 TOWNS (A, B, C) ARE LOCATED AS FOLLOWS. DETERMINE THE MOST SUITABLE PLACE TO LOCATE THE ELECTRICAL POWER STATION TO SUPPLY THOSE TOWNS.

A – 1000 mw (3, 5) km,

B – 300 mw (7, 10) km,

C – 400 mw (4, 17) km



$$\bar{X} = \frac{P_A X_A + P_B X_B + P_C X_C}{P_A + P_B + P_C}$$

$$= \frac{1000 \times 3 + 300 \times 7 + 400 \times 4}{1000 + 300 + 400} = 3.94 \text{ km}$$

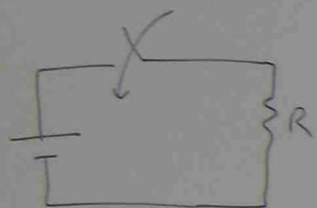
$$\bar{Y} = \frac{P_A Y_A + P_B Y_B + P_C Y_C}{P_A + P_B + P_C}$$

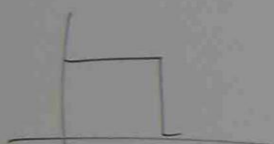
$$= \frac{1000 \times 5 + 300 \times 10 + 400 \times 17}{1000 + 300 + 400}$$

$$= 8.7 \text{ km}$$

Exponential function

$$Y = e^{x} \qquad e = 2.718$$

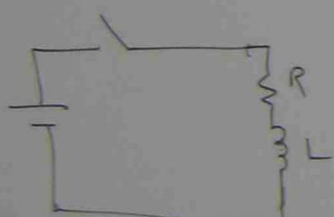




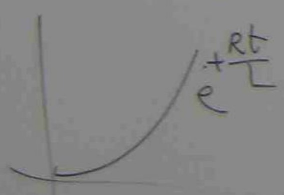
Resistor

Switching on

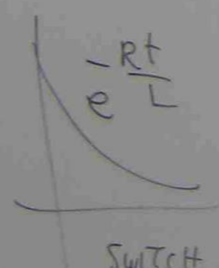
Transient circuits



R = Resistance
L = Inductance
t = Time

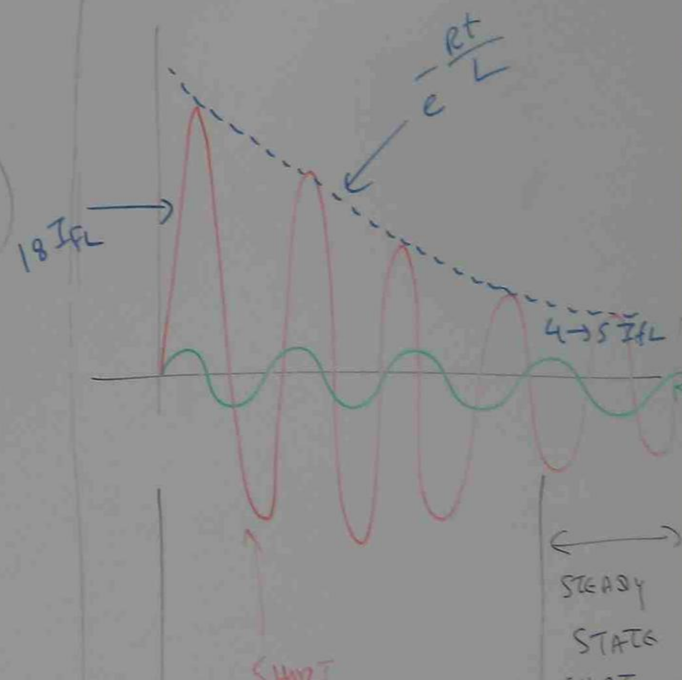


Switch on



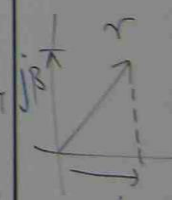
Switch off

Short circuit current



Transient short circuit current

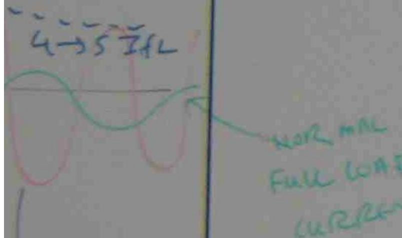
γ = Propagation constant



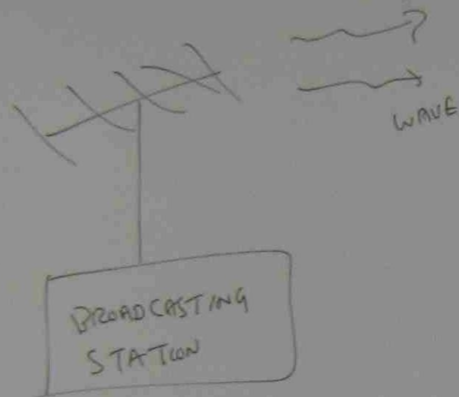
Horizontal component of propagation constant

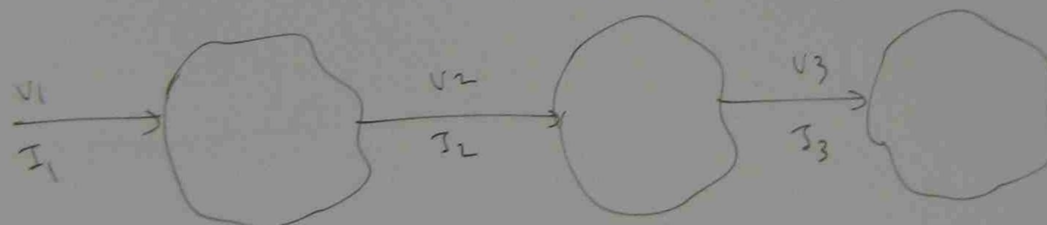
$\frac{V_1}{I_1}$

$\frac{V_1}{V_2} =$



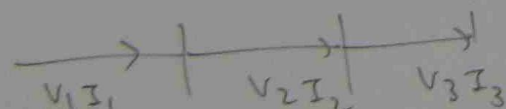
STEADY STATE SHORT CIRCUIT CURRENT





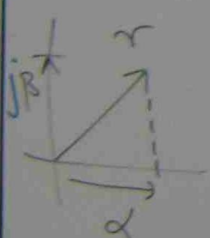
WAVE PROPAGATION

γ = PROPAGATION CONSTANT



$\gamma = \alpha + j\beta$

$\gamma_1 = \alpha_1 + j\beta_1$



$$\frac{V1}{V_2} = e^{\gamma 1} \qquad \frac{V2}{V_3} = e^{\gamma 2} \qquad \frac{V3}{V4} = e^{\gamma 3}$$

HORIZONTAL COMPONENT OF PROPAGATION CONSTANT

$j\beta$ = VERTICAL COMPONENT OF PROPAGATION CONSTANT

(a) $5\angle 36.8 = 5\cos 36.8 + j5\sin 36.8 = 5\times 0.8 + j5\times 0.6 = 4 + j3$

(b) $5\angle -36.8 = 5\cos(-36.8) + j5\sin(-36.8) = 5\times 0.8 - j5\times 0.6 = 4 - j3$

(c) $5\angle -120 = 5\cos(-120) + j5\sin(-120) = 5(-0.5) + j5(-0.866)$

$= -2.5 - j4.33$

(d) $5\angle 250 = 5\cos(250) + j5\sin(250) = 5(-0.342) + j5(-0.939)$

$= -1.71 - j4.695$