ed

Date: 31 / 10 / 2022

Frequency tolerance

48.5 - 51.5 Hz

* Estimation of load

Parameters for estimation of load

→ Demand factor

Ratio of max demand to total connected load.

$$D.F = \frac{\text{Max demand}}{\text{Total connected load}}$$

↓

sum of individual load capacity (kW)

- Should be less than 1
- 0.8-0.9 → no unnecessary load
- < 0.5 → extraneous load

→ Load factor

$$L.F = \frac{\text{Avg. Load}}{\text{Max Demand}},$$

if system is operating for specific no. of hours.

genuin

Date:

$$\text{Avg load} = \frac{\text{energy/unit } \cancel{\text{connected}} \text{ consumed in day/month/year}}{\text{Duration (day/month/year)}}$$

- L.F = = 1 → Avg = = max demand
L.F = = 0.5 → Avg is 50% of max capacity

→ Diversity Factor

$$\text{Div. F} = \frac{\text{sum of individual max demand of various subsection of system}}{\text{Max demand of entire system}}$$

e.g. i) 8 lamps 55 W each
ii) 6 fans 60 W each
iii) 2 refridgerator 300 W each
iv) 1 AC 1500 W
v) 1 T.V 150 W
vi) 1 Heater 1000 W

a) Calculate total amount of current taken from the suppy at voltage of 230 V rms

b) Energy consumed in a day if all equipment are in use 5 hrs /day

genuin

Date:

c) Calculate demand factor & load factor for this system

→ a) Tot Load = $8 \times 55 + 6 \times 60 + 2 \times 300 + 1500$
$+ 150 + 1000$
$= 4050$ W

~~Current~~ I =
$P_L = VI \cos\phi$
$\cos\phi \approx 1$ → assuming for residential load.

$I = \frac{4050}{230} = \boxed{17.60 \text{ A}}$

b) $P_L = 4.05$ kW
$E = 4.05 \times 5 = 20.25$ kWh

c) Demand factor & load factor

$D.F = \frac{4050}{4050} = \boxed{1}$

$L.F = \boxed{1}$

genuin

Date:

e.g. The domestic load in residential area is used in following manner.

i) Fluorescent lamp 4 → 55 W each, 6 hrs/day

ii) 4 fans 70 W each, 8 hrs/day

iii) 1 refridgerator 300 W, 16 hrs/day

iv) 1 Heater 1000 W, 2 hrs/day

v) T.V. 150 W, 8 hrs/day

Calculate connected load & load factor for the system

→ Tot. load $= 4\times55 + 4\times70 + 300 + 1000 + 150$

$= \boxed{1950\ W}$

Tot. Energy $= \dfrac{4\times55\times6 + 4\times70\times8 + 300\times16 + 1000\times2 + 150\times8}{1000}$

$= 11.56$ kWh

Max dem./day $= \dfrac{1950}{1000}\times24 = 46.8$ kWh

$L.F = \dfrac{11.56}{46.8} = \boxed{0.247}$

genuin

Date:

eg. i) 15 lens - 230 V - 100 W
ii) 3 ovens - " 1 kW
iii) 5 fans - 230 V 80 W

a) → Effective resistance? &
b) → Current taken up by this workshop to turn on each load
c) → Determine total unit consumed per day if workshop is operating for 8 hrs/day
d) → Calc monthly elec bill at the rate of 5.75 ₹/unit. Consider the month of 30 days

Ans

Tot load = $1500 + 3000 + 400 = 4900\ W$

a) $P = V^2/R_L \qquad R_L = \cancel{4900}\ \frac{(230)^2}{4900} = \boxed{10.8\ \Omega}$

c) Tot unit cons in 8 hrs $= 4.9 \times 8 = \boxed{39.2\ kWh/day}$

d) Bill $= 39.2 \times 30 \times 5.75$

$= \boxed{₹\ 6762}$

b) $\cancel{I_1 = \frac{100}{230} = 0.434A \qquad I_2 = \frac{1000}{230} = 4.34A}$

$\cancel{I_3 = \frac{80}{230} = 0.347A}$

$I_L = P/V = \frac{4900}{230} = \underline{21.3\ A}$

Date:

$P = VI\cos\phi$

Long distance $\rightarrow$ Extra High voltage (EHV)

UHV

T & D losses

Transmission and

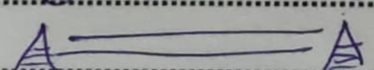
$R = \frac{\rho L}{A}$

$A \downarrow \rightarrow I \downarrow$

* $\boxed{\text{Skin Effect}}$

High voltage DC lines are used

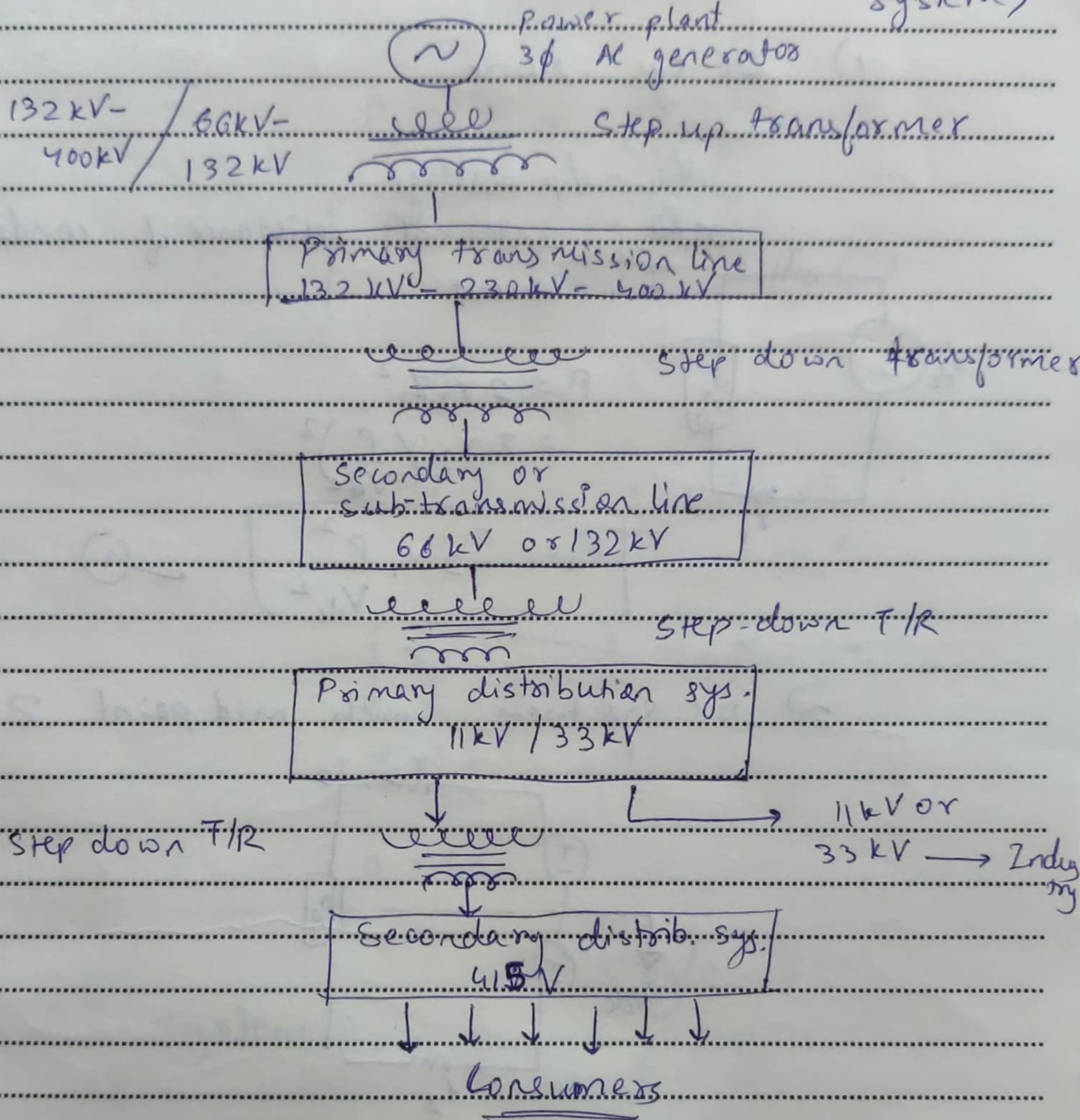
AC to DC $\downarrow$ DC to AC $\downarrow$



$\downarrow$

can be used for bi-directional power flow

* Single line diagram of EPS (Electrical Power System)



Date:

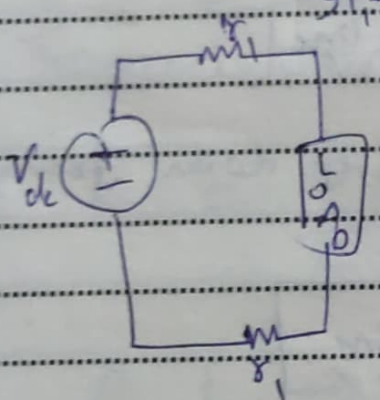
→ DC System: → 2 wire system
→ 2 wire with mid-point

1) DC sys - 2 wire

V_{dc} - i/p voltage

r_1 = internal resistance of conductor

I_1 = current

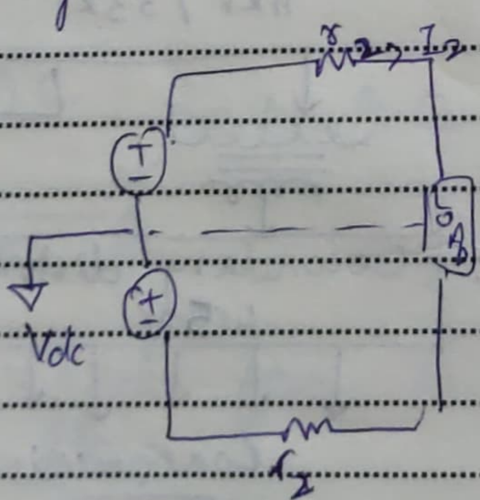


$P = 2 r_1 I_1^2$

$= 2 r_1 \left(\frac{P}{V_{dc}}\right)^2$

$$\boxed{P_1 = 2 r_1 \frac{P^2}{V_{dc}^2}} \quad (1)$$

2) DC system with mid point 2 wire



genuin

Date:

$$P_2 = 2 r_2 I_2^2$$

$$I_2 = \frac{P}{2V_{dc}}$$

$$P_2 = 2 r_2 \left(\frac{P}{V_{dc}}\right)^2$$

$$\boxed{P_2 = \frac{1}{2}\left(\frac{P}{V_{dc}}\right)^2 \times r_2} \quad -(2)$$

(1) = (2)

$$\frac{2 r_1 P^2}{V_{dc}^2} = \frac{1}{2} r_2 \frac{P^2}{V_{dc}^2}$$

$$\boxed{\frac{r_1}{r_2} = \frac{1}{4}} \qquad r_1 = \frac{1}{4} r_2$$

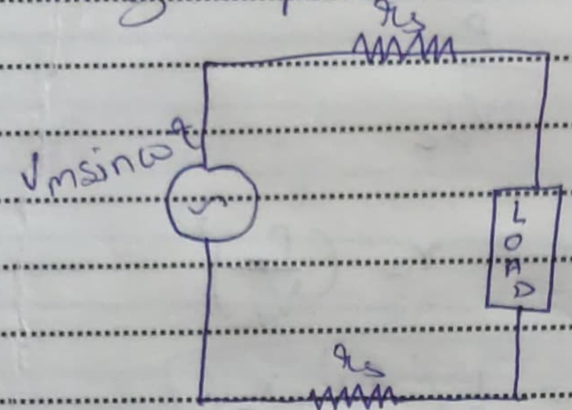
$$r \propto \frac{1}{a}$$

$$a_1 = 4a_2$$

→ AC system : — single - ϕ
— 3 - ϕ

Date: 21/11/2022

1) Single phase AC - 2 wire system.



$V_s = V_m \sin\omega t$

$P = V_{rms} I_{rms} \cos\phi$

$$I_{rms} = \frac{P}{V_{rms}\cos\phi} = \frac{P}{\frac{V_m \cos\phi}{\sqrt{2}}}$$

$$= \frac{\sqrt{2}\,P}{V_m \cos\phi}$$

$$P_L = 2 I_{rms}^2 r_s$$

$$P_L = 2\left(\frac{P}{(V_m/\sqrt{2})\cos\phi}\right)^2 r_s$$

$$= \frac{4P^2}{V_m^2 \cos^2\phi} r_s$$

Comparing with 2 wire DC system.

Date:

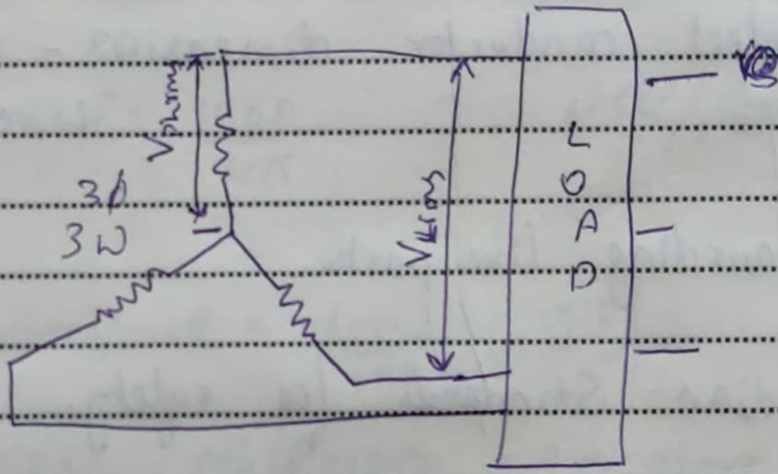
for same power

$$\frac{r_1}{r_s} = \frac{2}{\cos^2\phi}$$

where, r_1 is the resistance in case of DC system.

r_s = equivalent resistance of AC conductor.

2) 3ϕ 3 wire star



$I_{rms} = I_L$ $\quad V_{ph} = \frac{V_L}{\sqrt{3}}$ $\quad I_{ph} = I_L$

$P_{3\phi} = \sqrt{3}\, V_{L\,rms}\, I_{rms} \cos\phi$ $\quad V_{L\,rms} = \sqrt{3}\, V_{ph\,rms}$

or $3\, V_{rms\,ph}\, I_{rms\,ph} \cos\phi$

V_{rms}, I_{rms} → Phase Quantity

genuin

Electrical Safety

Date: 28/11/2022

bet^n Phase & load in series

7-10 A MCB → Appliance safety, load safety

30, 100, 300 mA as per need ELCB → Human safety

↓

bet^n earth & neutral

→ If ELCB trips → entire system will be disconnected

→ Limits of current from Google
Current range → Reaction

→ Select conductor dimension – Standard wire gauge

→ Gaurding live parts

→ Indian Standards for safety.

genuin

Date:

→ In 250 V , total flux 1500 lumens & takes a current of 0.4 A. Calculate
i) Lumen/Watt
ii) MSCP/Watt

$$MSCP = \frac{F}{4\pi}$$

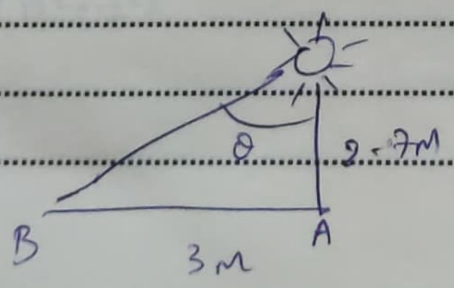
Wattage(W) = VI

$W = 250 \times 0.4 = \underline{100 W}$

ii) $MSCP = \frac{1500}{4\pi}$ $MSCP/watt = \frac{1500}{4\pi \times 100}$

i) $Lumen/watt = \frac{1500}{100} = \boxed{15}$

→ 500 W , MSCP = 1250 , 2.7 m above the ~~working~~ Calculate i) illumination directly below the lamp at working plane.
ii) Lamp efficiency , iii) Illumination at a point 3 m away in the horizontal plane from vertically below the lamp.



genuin

i) Illumination (E_A) $= \frac{I}{d^2}$

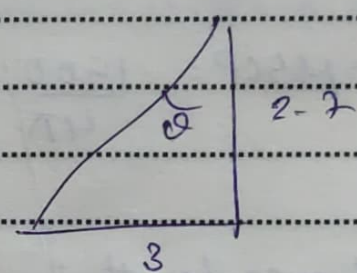
$I = 1250$, $h = 2.7m$

(ii) Lamp efficiency $=$ ~~tum~~ $\frac{\text{luminous flux}}{W}$

$= \frac{MSCP \times 4\pi}{W}$

$= 31$ lumen/watt

(iii) $E_B = \frac{I}{h^2} \cos^3\theta$



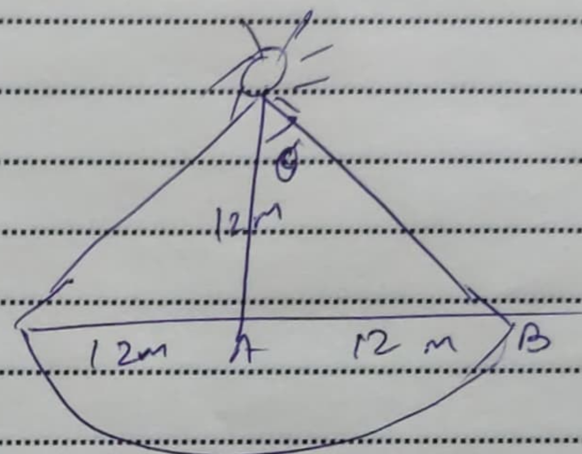
$= \frac{1270}{2.7^2} \times \frac{(2.7)^2}{\sqrt{((2.7)^2 + 3^2)}}$

$= 51.3$ lux

J B Gupta

Date:

→ Lamp with a reflector is mounted 12 m above the center of a circular area of 24 m diameter. If the combination of lamp & reflector gives a uniform CP (Candle Power) of 1000 over the circular area. Calc max & min illumination produced on the area. ; $h = 12m$



i) $E_A = \frac{CP}{h^2}$ → max illumination

$= \frac{1000}{12^2}$

$\cancel{\frac{1000}{\sqrt{(12^2+12^2)}} \times 12^3}$