Electric Power Distribution Systems II

EME410

Spring 21-22

Lecture 2

Voltage Drop Calculation

INSTRUCTOR

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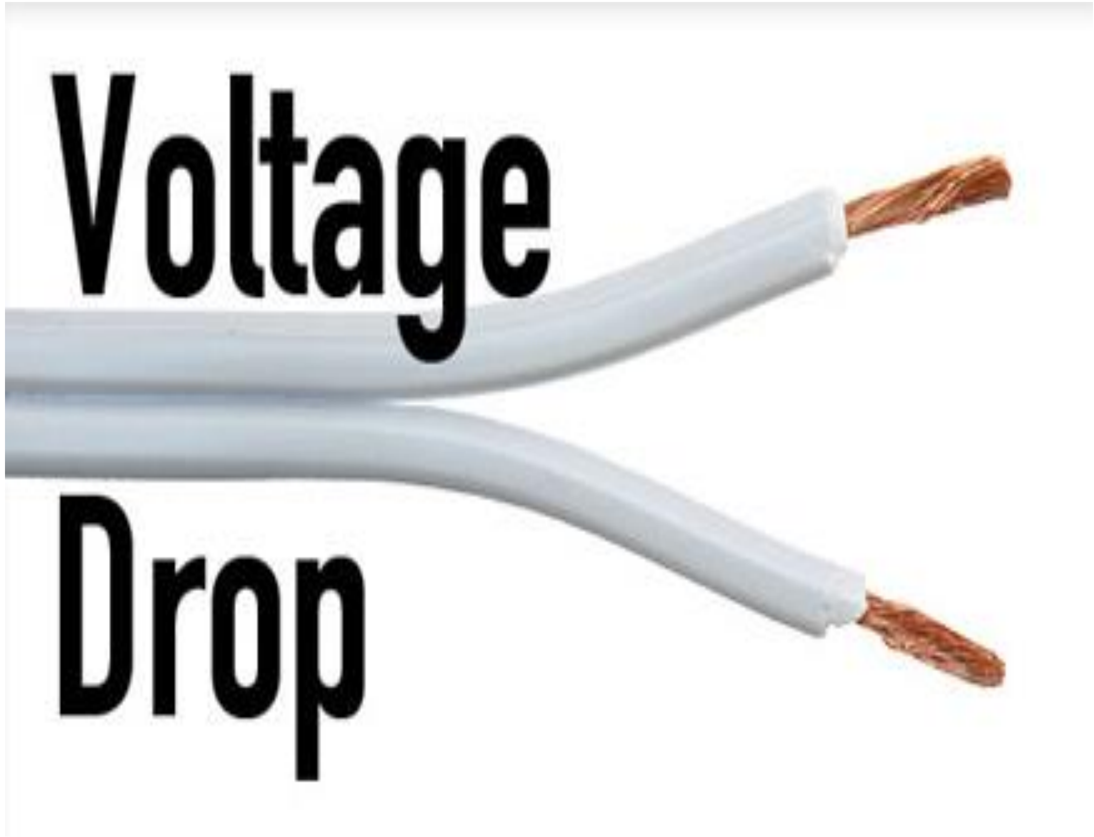
➢ Contents

1) Cable Design.

2) Voltage Drop Calculation.

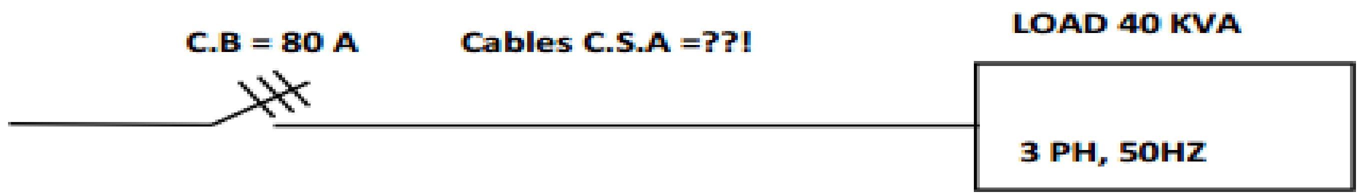


Cable Design

Cables are designed according to:

- Current carry capacity or thermal rating.
- Voltage drop.
- Short circuit level.

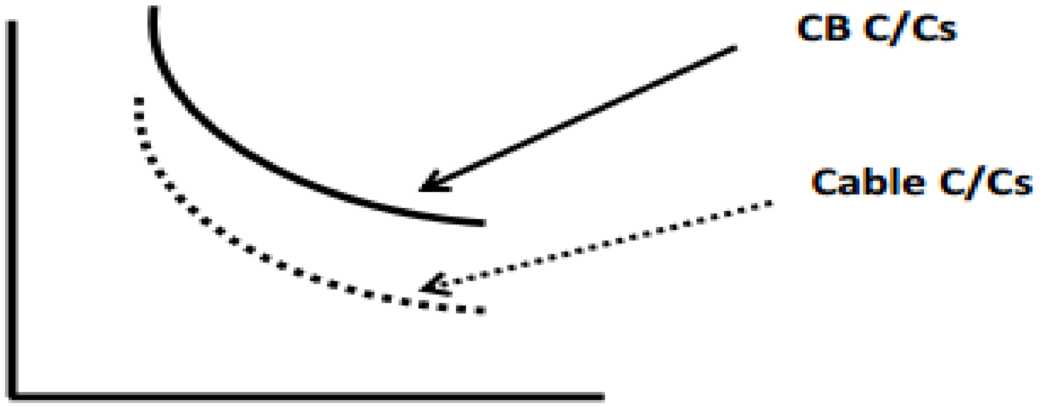
[1] *Current Carry Capacity:-*



I_{rated} = 40 x 1.5 = 60 Amp

$I_{C.B}$ = 60 x 1.25 = 75 Amp → C.B = 80 Amp

$$I_{cable} = \frac{C.B}{Derating\ Factor}$$



- So must select C.B before cable.
- C.B rating depends on (KVA of load).
- Cable sizing depends on C.B rating.

Types of Derating Factor:-

a) Ambient temperature Derating factor
b) Ground temperature Derating factor
c) Grouping factor
d) Burial depth Derating factor
e) Soil thermal resistivity

Air temperature derating factor

Air temperature °C	25	30	35	40	45	50	55
PVC cables rated 70 °C	1.22	1.15	1.08	1.00	0.95	0.82	0.71
XLPE cables rated 90 °C	1.14	1.10	1.05	1.00	0.90	0.89	0.84

Ground temperature derating factor

Ground temperature °C	25	30	35	40	45	50	55
PVC cables rated 70 °C	1.13	1.07	1.00	0.93	0.85	0.76	0.65
XLPE cables rated 90 °C	1.09	1.04	1.00	0.95	0.90	0.85	0.80

Burial depth derating factor

Depth of laying mt.	Cables cross section		
	Up to 70 mm^2	95 upto 240 mm^2	300 mm^2 & above
0.50	1.00	1.00	1.00
0.60	0.99	0.98	0.97
0.80	0.97	0.96	0.94
1.00	0.95	0.93	0.92
1.25	0.94	0.92	0.89
1.50	0.93	0.90	0.87
1.75	0.92	0.89	0.86
2.00	0.91	0.88	0.85

Soil thermal resistivity derating factor

Soil thermal resistivity in °C. Cm / Watt	80	90	100	120	150	200	250
Rating factor	1.17	1.12	1.07	1.0	0.91	0.80	0.73

Derating Factor

Air

- ➔ Temp➔Temp
- ➔ Grouping Factor➔ Depth
  - ➔ Soil Thermal

Take T_A = 50°c

So, for **PVC** take 0.82

For **XLPE** take 0.89

Ground

Take T_g = 50°c

So, for **PVC** take 0.76

For **XLPE** take 0.85

(for depth = 80 Cm)

Ex

$$I_{cable} = \frac{C.B}{D.F}$$

Temp = 50°c → PVC → $D.F_T$= 0.82

Single cable → $D.F_G$= 1

$$I_{cable} = \frac{80}{0.82} = 97 \text{ Amp}$$

From Elsewedy Catalogue: chose **<u>Cu/PVC/PVC 4 X 25 + 16 mm²</u>**

Multicore Cables, with Stranded Copper Conductors PVC Insulated and PVC Sheathed

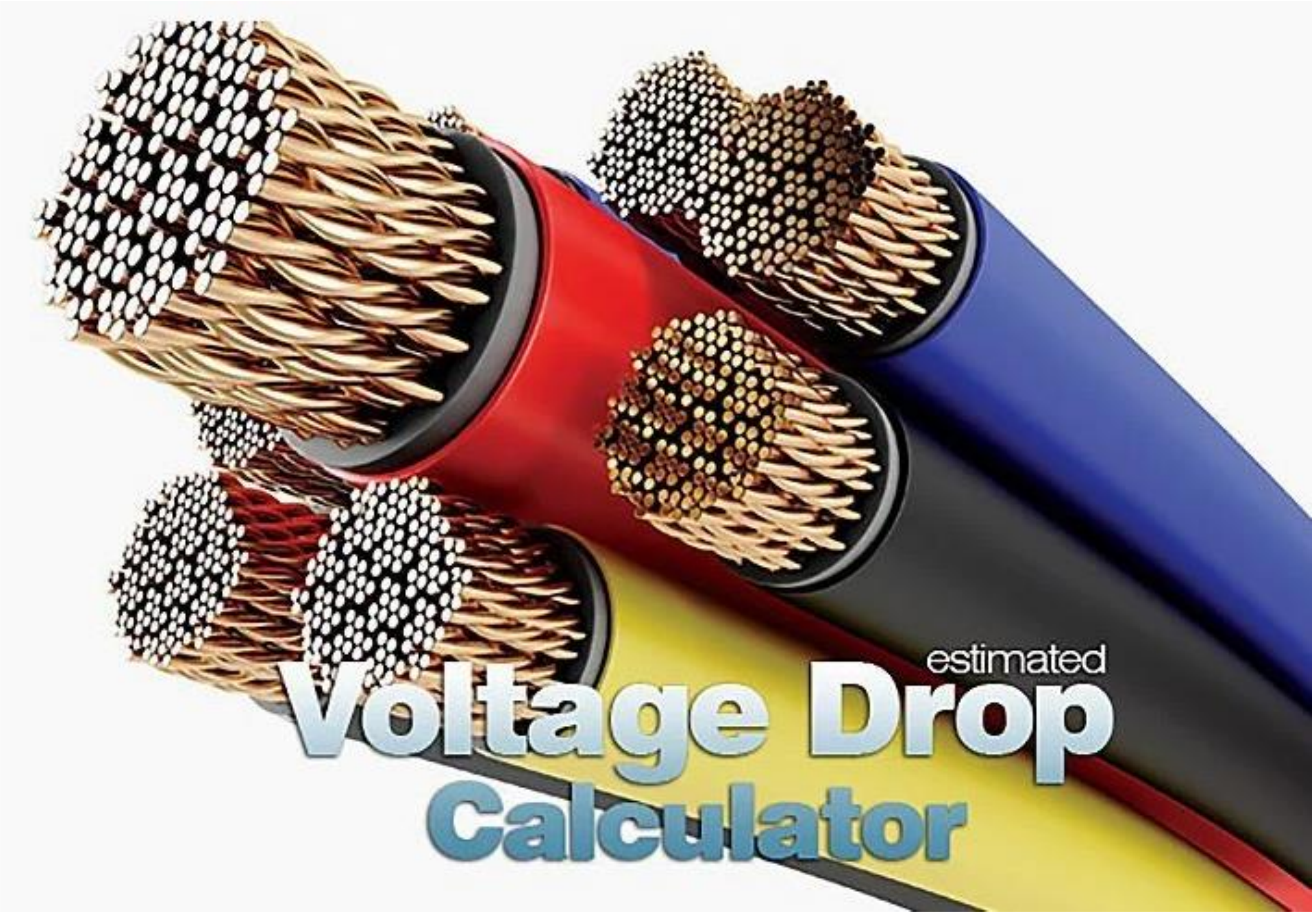
Description

- Multicore cables of stranded Copper conductors are insulated with PVC compound rated 70°C, assembled together, covered with overall jacket of PVC compound.
- Cables are produced according to IEC 60502 or BS 6346.

Application

- For outdoor and indoor installations in damp and wet locations.

Product - Code	Nominal Cross Sectional Area		Max. Conductor Resistance		Current Rating			Approx. Overall Diameter	Approx. Weight
			DC at 20 °C	AC at 70 °C	Laid Direct in Ground	Laid in Ducts	Laid in Free Air		
	mm²		Ω/km	Ω/km	A	A	A	mm	kg/km
Four Core Cables									
CP1-T104-U04	1.5	rm	12.1000	14.6000	21	18	18	11.4	180
CP1-T104-U06	2.5	rm	7.4100	8.8700	27	23	22	12.4	230
CP1-T104-U08	4	rm	4.6100	5.5400	35	30	31	14.8	335
CP1-T104-U09	6	rm	3.0800	3.6900	45	3A	39	16.0	425
CP1-T104-U10	10	rm	1.8300	2.1900	60	48	53	17.9	635
CP1-T104-U11	16	rm	1.1500	1.3900	75	60	[illegible]	20.3	880
CP1-T104-U12	25	rm	0.7270	0.8700	100	80	94	23.9	1295
CP1-T104-U13	35	rm	0.5240	0.6280	120	95	110	26.6	1700
CP1-T104-U14	50	sm	0.3870	0.4640	145	115	138	29.3	2225
CP1-T104-U15	70	sm	0.2680	0.3220	175	145	[illegible]	32.9	3065
CP1-T104-U16	95	sm	0.1930	0.2320	210	165	209	[illegible]	4175


estimated
Voltage Drop
Calculator

Voltage drop is defined as the amount of **voltage loss** that occurs through all or part of a circuit due to impedance. The simplest way to reduce *voltage drop* is to increase the diameter of the conductor between the source and the load, which lowers the overall resistance.

[2] Voltage Drop calculation:-

$$V.D = (mv / amp / m) \times 10^{-3} \times I_{actual} \times L$$

Where:

I_{actual}: load rated current.

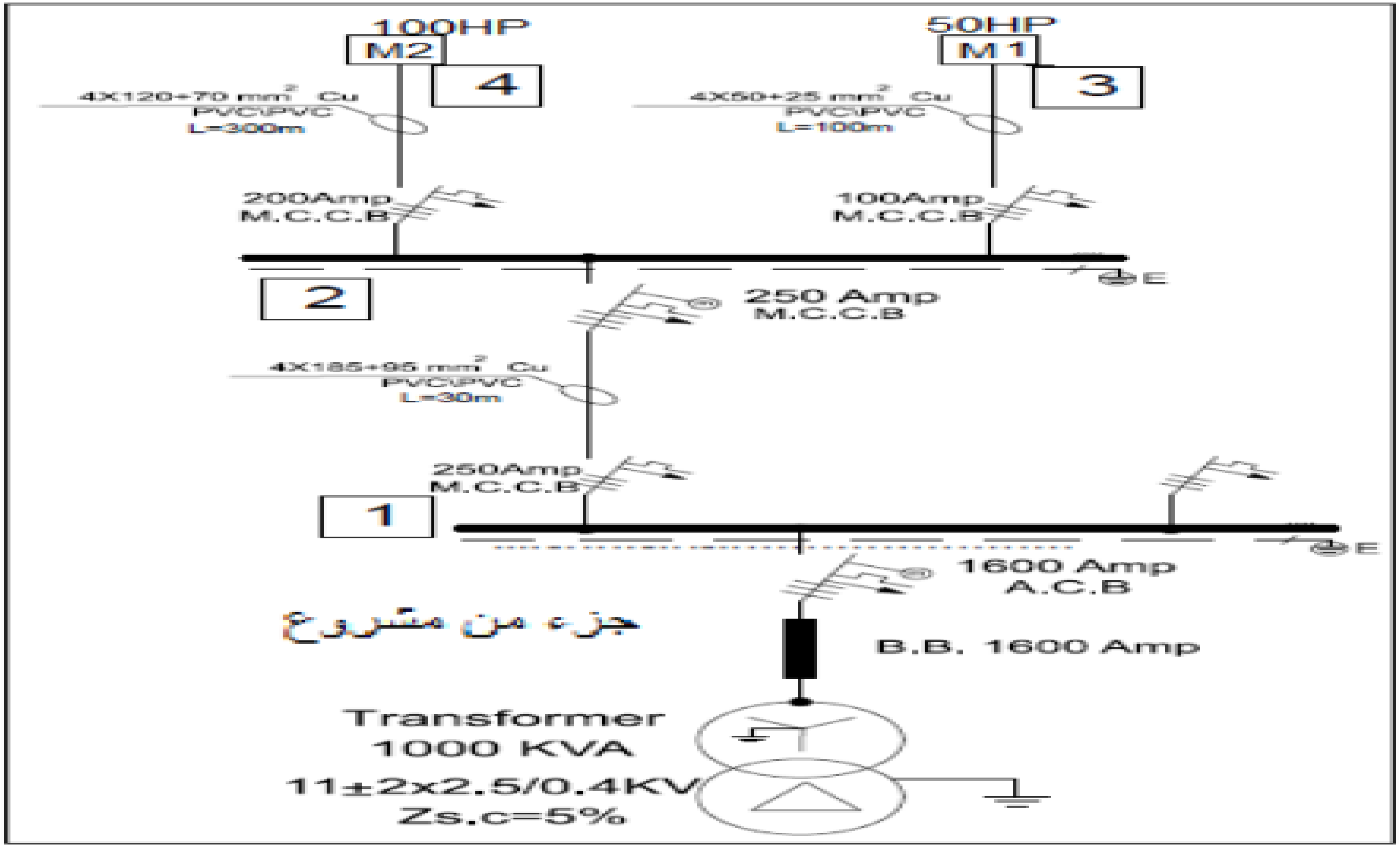
L: Cable length.

(mv / amp / m): Factor get from cable catalogue.

Note:-

- Accepted voltage drop is **V.D≤ 5%**
- V.D % = (V.D / 380) x 100

- EX-
- Calculate the voltage drop of two motor 50hp and 100hp



For motor – 1 :- p = 50 HP

I_{rated} = 50 x 1.5 = 75 A. $I_{C.B}$ = 75 x 1.25 = 94 A.   → ***C.B = 100 A***

$I_{cable} = \frac{100}{0.8}$ = 125 A. → ***4x50 + 25 mm² Cu/PVC/PVC***

For motor – 2:- p = 100 HP

I_{rated} = 100 x 1.5 = 150 A. $I_{C.B}$ = 150 x 1.25 = 187.5 A   → ***C.B = 200 A***

$I_{cable} = \frac{200}{0.8}$ = 250 A. → ***4x120 + 70 mm² Cu/PVC/PVC***

For DB:-

Total KVA = 100 + 50 = 150 KVA

I_{rated} = 150 x 1.5 = 225 A. → ***C.B = 250 A***

$I_{cable} = \frac{250}{0.8}$ = 312.5 A. → ***4x185 + 95 mm² Cu/PVC/PVC***

Voltage Drop calculation:-

(From 1 ---- to ---- 2)

L = 30 mt ; I_{actual} = 225 A ; C.S.A = 185 mm^2

V.D = (mv / amp / m) x 10^{-3} x Iactual x L

V.D = 0.244 x 10^{-3} x 225 x 30 = **1.647 Volt**

V.D % = (1.647/380) x 100 = **0.433 %**

L = 100 mt ;I_{actual} = 75 A ; C.S.A = 50 mm^2

V.D = (mv / amp / m) x 10^{-3} x Iactual x L

V.D = 0.72 x 10^{-3} x 75 x 100 = **5.4 Volt**

V.D % = (5.4/380) x 100 = **1.42 %**

From 1 – to – 3 :::::::: **Total V.D = 1.42 + 0.433 = 1.835 %** **{Accepted}**

(From 2 ---- to ---- 4)

L = 300 mt ; I_{actual} = 150 A ;   C.S.A = 120 mm^2

V.D = (mv / amp / m) x 10^{-3} x Iactual x L

V.D = 0.341 x 10^{-3} x 150 x 300 = **15 Volt**

V.D % = (15/380) x 100 = **4 %**

From 1 – to – 4 :::::::: **Total V.D = 4 + 0.433 = 4.435 %**   **{Accepted}**

Note:-

If total V.D % > 5 % (not accepted) we have to solve this problem.

As   V.D = (mv / amp / m) x 10^{-3} x Iactual x L , so if the (mv / A / m) reduced the V.D will be reduced as well.

So, we select the next higher C.S.A cable.

C.S.A ↑   →   (mv / A / m) ↓   →   V.D ↓   →   V.D% ↓↓


Thank
you