



Birzeit University
Faculty of Engineering and Technology
Department of Electrical and Computer Engineering
Protection and Automation in Electrical Power Systems
ENEE 5306

Midterm Exam – Part 2

8 May 2021

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Time: 25 min

Student Name:

ID Number:

Question # 2: Fuse-Fuse Coordination

[40 points]

Consider the typical 33 kV radial distribution system with the topology shown in Fig. 2 **without DG**. All bus loads are 1 MW with power factor 0.9 x . The maximum fault current at each position of protection device are given in Table I in the next page.

Note: x is the last digit of your university ID Number, **for example if your ID is 1172025**, then the power factor of all loads are the same and equal to 0.9 5)

- a) Find the maximum normal current flowing through each protection device.
- b) Select fuse ratings (Type) that will coordinate properly.

After solving parts (a) and (b), summarize your results by drawing a Table as the Table II in the next page.

- c) If a distributed generation is connected to Bus 4 as shown in Fig. 2, describe the fault current passing through each protection device as shown in the Table II in the next page.
- d) Discuss the coordination between Fuse1 and Fuse2 in presence of this DG (DG connected to Bus 4 as shown).

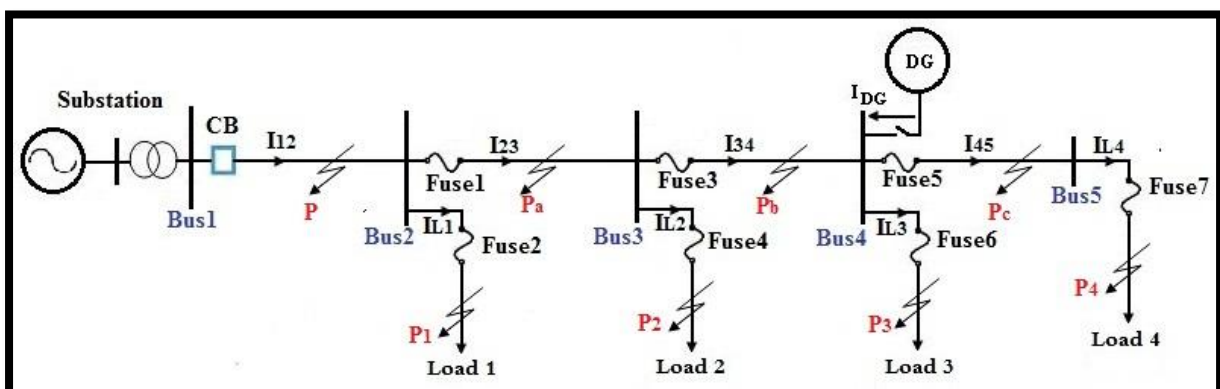


Fig. 2: Single Line Diagram for question # 2

TABLE 3.7 Continuous Current-Carrying Capacity of EEI-NEMA Fuse Links

EEI-NEMA K or T Rating	Continuous Current (amperes)	EEI-NEMA K or T Rating	Continuous Current (amperes)	EEI-NEMA K or T Rating	Continuous Current (amperes)
6	9	20	30	65	95
8	12	25	38	80	120†
10	15	30	45	100	150†
12	18	40	60*	140	190
15	23	50	75*	200	200

TABLE I. NORMAL OPERATION AND FAULT ANALYSIS WITHOUT DG

PD	Max. Load Current (A)	Max. Fault Current (kA)	PD Type
CB		2.4551	CO-9
Fuse1		1.4763	
Fuse2		1.3117	
Fuse3		1.0538	
Fuse4		0.9780	
Fuse5		0.8236	
Fuse6		0.7781	
Fuse7		0.6444	

TABLE II. FAULT CURRENT PASSING THROUGH PD

Fault Position	Description of the Fault Current in terms of I_S and I_{DG}
P_b	$I_{CB} =$ $I_{Fuse1} =$ $I_{Fuse3} =$ $I_{Fault} =$
P	$I_{CB} =$ $I_{Fault} =$ $I_{Fuse3} =$ $I_{Fuse1} =$
P_4	$I_{CB} =$ $I_{Fuse1} =$ $I_{Fuse3} =$ $I_{Fuse5} =$ $I_{Fuse7} =$ $I_{Fault} =$
where: <ul style="list-style-type: none"> ▪ I_{CB} and I_{Fuse} are faults current seen by Circuit Breaker (CB) and the Fuse respectively. ▪ I_S and I_{DG} mean fault current flowing from substation and DG respectively. 	

Protecting		Protected link rating (amperes)												
Fuse Link	8T	10T	12T	15T	20T	25T	30T	40T	50T	65T	80T	100	140	200
Rating, A	Maximum fault current at which B will protect A (amperes)													
6T	350	600	920	1200	1500	2000	2540	3200	4100	5000	6100	9700	15.2	
8T		375	800	1200	1500	2000	2540	3200	4100	5000	6100	9700	15.2	
10T			530	1100	1500	2000	2540	3200	4100	5000	6100	9700	15.2	
12T				680	1280	2000	2540	3200	4100	5000	6100	9700	15.2	
15T					730	1700	2500	3200	4100	5000	6100	9700	15.2	
20T						990	2100	3200	4100	5000	6100	9700	15.2	
25T							1400	2600	4100	5000	6100	9700	15.2	
30T								1500	3100	5000	6100	9700	15.2	
40T									1700	3800	6100	9700	15.2	
50T										1750	4400	9700	15.2	
65T											2200	9700	15.2	
80T												7200	15.2	
100T													4000	13.8
140T														7.5