Power Quality and Reliability Benchmarking Questions:

Problem 1:
As part of a power quality and reliability study, your job is to calculate several different power quality and reliability indices for a specific distribution feeder based on tabulated event data.

Assumptions:
In this study, the tabulated data was collected over a total of 60 days in four separate 15-day periods spaced throughout the year to reflect seasonal variations in power quality and reliability. Assume a 365-day year. Assume the data is typical for the times of the year in which it was collected.

The distribution feeder serves a total of 1400 customers.

s=seconds c=cycles m=minutes

Event	Voltage (percent of nominal)	Event Duration	Customers Affected
1	0%	30s	1400
2	92%	3c	550
3	87%	10c	230
4	85%	16c	540
5	72%	1s	128
6	8%	2s	150
7	5%	20c	320
8	43%	15c	520
9	28%	8c	400
10	49%	16c	150
11	63%	23c	240
12	68%	21c	630
13	0%	32m	75
14	74%	15c	875
15	67%	43c	300
16	42%	38c	120

Problem 1 questions:
Calculate the **expected annual values** for this feeder of the following indices.

1a) (3 pts) $SARFI_{90}$
1b) (3 pts) $SARFI_{80}$
1c) (3 pts) $SARFI_{70}$
1d) (3 pts) $SARFI_{50}$
1e) (3 pts) $SARFI_{10}$
1f) (5 pts) $SIARFI_{70}$
1g) (5 pts) $SMARFI_{70}$
1h) (5 pts) SAIFI

Problem 2: A large industrial customer has negotiated a power quality contract with its serving utility company similar to the contracts described in section 8.5 of the PSQ text. This power quality contract includes the rules described on page 381-382 of the PSQ text, and the sag score in this contract is calculated according to equation 8.7.

Note: The class text is slightly confusing regarding the calculation of voltage sag payments. Assume that the voltage sag payment is made in one lump sum at the end of the year, based on the cumulative sag score at the end of the year.

Given: The SGPA is $75,000. The sag score target for each year is 4.0. Part of the way through the year, the cumulative sag score is at 3.7, and then the following voltage sags occur on four separate days, in the order listed:

Sag number:	A-phase minimum voltage	B-phase minimum voltage	C-phase minimum voltage
1	100%	75%	60%
2	73%	70%	68%
3	62%	65%	73%
4	96%	89%	87%

Problem 2 questions:

2a) (15 points) Starting with the cumulative sag score of 3.7 described above, calculate the new cumulative sag score following each of the voltage sags listed above.

2b) (10 points) Calculate the incremental increase (rounded to the nearest dollar) in the total voltage sag payment that will be due at the end of the year for each of the four voltage sags listed above, and calculate the total end-of-year payment if no other sags occur after those listed above.

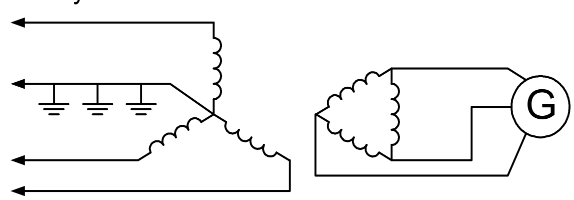
DG/DR Questions:

Problem 3: Short answer (5 points each):

3a) Which two standards describe the harmonic distortion limits for distributed generators in the U.S.?

3b) Give two examples of “Distributed Resources” that are NOT “distributed generators” and list two ways that this type of distributed resource might be used in a distribution system.

3c) List two advantages and three disadvantages of using the transformer connection below to connect a DG to the utility distribution system.



Problem 4: Short answer (may require some independent study):

4a) (10 pts) An office building is served from a spot-network, and the building has a local distributed generator. Why is it critical that the output of the building's electrical generator not exceed the building's electrical load?

4b) (10 pts) Explain briefly how a destabilizing signal in the frequency control system of a DG would be used to prevent islanding.

4c) (10 pts) A non-islanding inverter (as defined in IEEE std. 929-2000) will cease to energize the utility line in 10 cycles or less if either of two conditions is true. Describe both of these conditions. (See the Sandia report on Anti-Islanding on the class PQ Links page for 4b and 4c.)