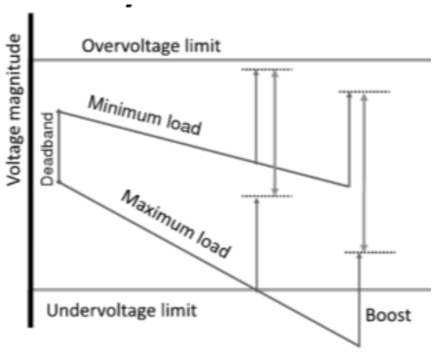
Tutorial 3 Voltage Variation, Faults and Stability

1) Define the "Overvoltage margin". Show the overvoltage margin on the voltage profile below and how it is relevant to the host capacity of distributed renewable generation.



2) A renewable DG is connected to an 11-kV feeder. The resistance between the DG source and the feeder bus is 5 ohms and the overvoltage limit is 105%. Assuming the bus voltage is nominal and constant before the DG is installed, estimate the maximum power rating of the DG in terms of overvoltage limit. (when there is no reactive power generation or consumption)

3) Based on the table and conditions shown below, calculate the Hosting Capacity (HP) determined by the overvoltage margin when:

The connection is through a feeder of 1 km at a cross-section area of 50 mm^2.

Using tap change, the distribution transformer has boosted the voltage by 5%.

The overvoltage limit is 108%.

The voltage drop caused by the minimum-load condition is 1%.

The deadband for voltage regulation is between 101% and 102%.

Hosting Capacity for 10 kV Feeders with 1% Overvoltage Margin

	Hosting capacity for feeder length				
Cross section (mm^2)	200 m	1 km	5 km	20 km	Loadability
25	7.4 MW	1.5 MW	300 kW	75 kW	2.5 MW
50	15 MW	3.0 MW	600 kW	150 kW	3.6 MW
120	36 MW	7.1 MW	1.4 MW	360 kW	6.0 MW
240	71 MW	14 MW	2.9 MW	710 kW	8.9 MW

4) Briefly explain how the following cable specifications affect the hosting capacity in terms of voltage magnitude (ignore the internal impedance of the DG):

the nominal voltage level

the cross-section area of the cable

over-voltage margin

the length of the cable

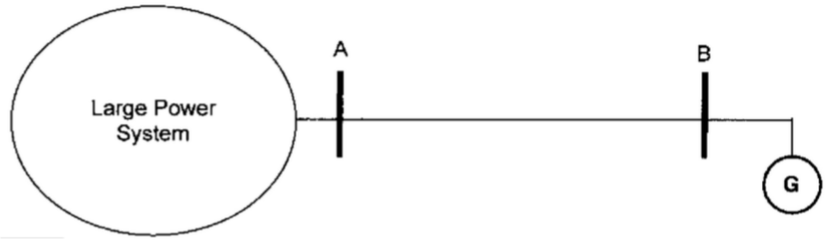
5) Outline the methods to increase the host capacity determined by constraints of voltage magnitudes.

6) What is a "fault" in power system?

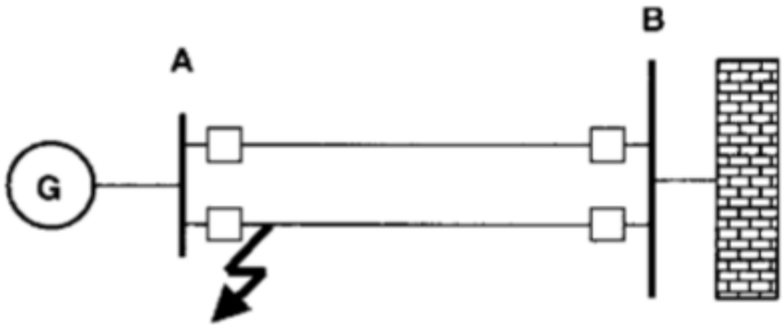
7) Why the fault current needs to be calculated when designing a power system?

8) The diagram below shows an embedded hydro generator plant connected to a large power system through a distribution network. Assuming the lines are purely inductive for simplicity, the impedances of

the large power system, between A and B, DG are is j0.2 p.u., j0.1 p.u. and j0.1 p.u. respectively. Using an equivalent circuit, compare the fault levels of Points A and B.



9) A DG of hydro generator is connected to an infinitive bus as shown below. The internal impedance of the DG is X_s = j0.25 p.u. and the line impedance are both X_L j0.8 p.u..



① Sketch the equivalent circuit.

② Find out the equivalent impedance between the DG source and the infinitive bus during normal operation.

③ Determine the power angle between the source and the infinitive bus during normal operation when the input mechanical power to the DG is 1 p.u.. (assuming both voltage sources at 1p.u.)

④ If a 3-phase bolt fault happens on one end of the cable as shown, find out the voltage magnitude of Point A during the fault and the power delivery from the DG to the grid.

⑤ Determine the post-fault equivalent impedance between the DG source and the infinitive bus.

⑥ If the input mechanical power to the DG is maintained at 1 p.u. after the fault clearance, biefely explain if the stability can be maintained.