**Assignment 4: Voltage Stability**

**[Q1]**

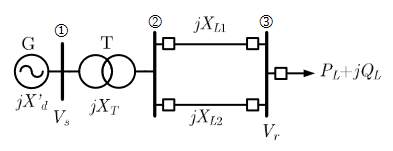


Figure 1: Single Line Diagram

Given parameters,

H = 8.45 MJoule/MVA

X’d = XT = 0.20 pu

XL1 = XL2 = 0.15 pu

Vbase = 220 kV

Sbase = 100 MVA

**Task 1:**

Where,

|Vs| = 1.05 pu

|Vr| = 1.0 pu

Xequiv = X’d + XT + (XL1 || XL2) = 0.475 pu

δ = 5,10,20,30,40 deg

Table 1: Results Task 1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| δ |  |  |  |  |  |
| Qs | 0.1189 | 0.1441 | 0.2438 | 0.4067 | 0.6278 |
| Qr | 0.0967 | 0.0717 | -0.028 | -0.1909 | -0.4119 |

From Table 1, we can conclude that the sending end reactice power increase with increase in power angle δ but the the receiving end reactive power decreases as the δ increases. When the sending end sends out periodic pulses of voltage every 1/60 second, it results in current pulses being “drawn” or flowing away from it. The timing and the magnitude of the resultant current pulses relative to the sent voltage pulses is determined by the sum of the impedance of both the equipment on the receiving end, and the transmission line itself between them. On the receiving end, the portion of the current drawn/flowing there which does not occur exactly at the same time as the voltage pulses results in reactive power at the receiving end. The transmissuon line also responds to the voltage pulses sent by the sending end by “drawing” or causing additional current flows which do not occur at exactly the same time ( i.e. “out of phase”) as the voltage pulses. This is reactive power “consumed by”or “caused by” the transmission line itself. This is the why there is difference in the reactive power seen by the sending and receiving ends.

**[Q2]**

Table 2: Results from MATLAB Script

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Power Factor** | **Inductive** | | |  | **Capacitive** | | |
| **0.85** | **0.9** | **0.95** | **1** | **0.95** | **0.9** | **0.85** |
| Pcrit [pu] | 0.5646 | 0.6163 | 0.6805 | 0.8206 | 0.94 | 0.9833 | 1.014 |
| Vcrit [pu] | 0.6009 | 0.6196 | 0.6481 | 0.7425 | 0.8953 | 0.9885 | 1.0793 |
| Pcrit [MW] | 47.991 | 55.467 | 64.6475 | 82.06 | 89.3 | 88.497 | 86.19 |
| Vcrit [kV] | 132.198 | 136.312 | 142.582 | 163.35 | 196.966 | 217.47 | 237.446 |

**[Q3]**

Figure 2: PV Curve from PowerFactory

Tabel 3: Results from PowerFactory Simulations

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Power Factor** | **Inductive** | | |  | **Capacitive** | | |
| **0.85** | **0.9** | **0.95** | **1** | **0.95** | **0.9** | **0.85** |
| Pcrit [MW] | 101.22 | 113.94 | 131.58 | 181.8 | 251.1 | 290.04 | 326.58 |
| Vcrit [kV] | 126.5015 | 131.3407 | 137.8676 | 156.6611 | 189.097 | 208.388 | 226.5633 |

From Table 3, we can conclude that both the critical power and critical voltages rises for increasing inductive power factor. But the critical power and critical voltage decreases as capacitive power factor increases.

From Table 2 and 3, we can compare and conclude that the critical voltages from both the simulation and calculation are almost equal with slight variations(5-11 kV), wheres for the critical power has huge variations.

**References**

[1] Prof FGL, “Assignment, Voltage Stability,” 2021

[2] Prof FGL, “Voltage Stability using DIgSILENT PowerFactory PV Curve”, available: https://youtu.be/KUorEwhzc6Q

[3] T. Van Cutsen; and C. Vournas, “Voltage stability of electric power systems”. Boston; London: Kluwer Academic Publishers, 1998