Brief Solution to PSP- find Exam - fall 2022 - Session 2019. 1/4

Q1 (a) Assessment of Zone-settings.

- Zone-1 should reach around 85% of the smaller lines -

  so it " " " $\simeq (0.85)(3+j30+1+j10) = 3.4+34j$.

  The given zone-1 of $(5.1+60j)$ is not correct as it over-reaches.

- Zone-2 should reach around 120% of the longer lines -

  so it " " " $\simeq (1.2)\left[3+j30+(1.3)(2+j20)\right] = 6.72 + 67.2j$

  Infeed correction factor $\left(1+\bar{I}_2/\bar{I}_1\right) = 1.3$

  The given setting of $(5.5+55j)$ is quite less than the calculated suitable value —

- Zone 3 should reach beyond next line section -

  so it " " $\simeq (3+j30)$

  $+(1.3)(2+j20)$

  $+(1.5)(1.3)(4+j40) = 13.4+134j$

  150% of DE; Infeed C. factor

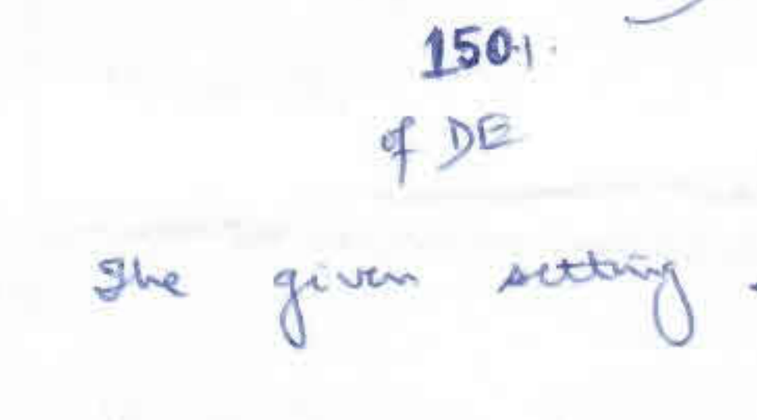
  The given setting fails to completely cover line DE.

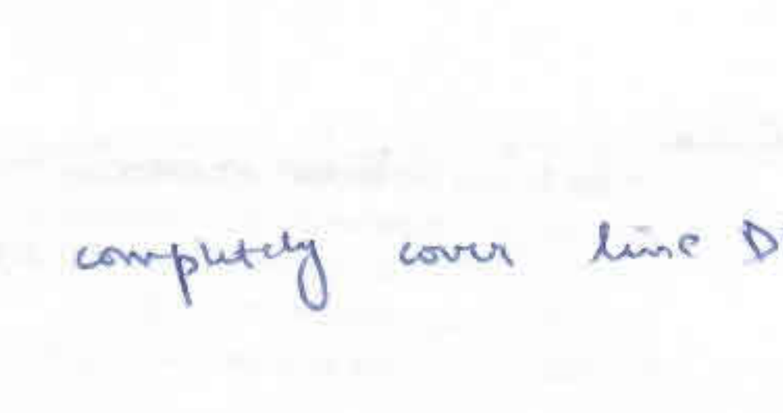
(b) Phase voltage and adjusted phase current -

  of E_a/I_a' where $I_a' = I_a + m I_0$ $\quad m = \frac{Z_0 - Z_1}{Z_1}$

(c) E_a/I_a'' where $I_a'' = I_a + m I_{01} + m' I_{02}$ $\quad m' = Z_{0m}/Z_1$

(d)





Q2 (a) Slope of the differential relay should be set so as to avoid tripping of the relay due to the differential current (I_d) that may flow b/c of the combined effect of Ratio-Mismatch, CT error, & LTC —

Ratio - Mismatch: The CT ratios on both sides of the power transformer are not exactly equal to the desired calculated ratios - b/c standardized values are used - hence a certain percentage of I_d flows —

C.T. Error: The CTs have errors - b/c of which they do not operate exactly as per the mentioned CT ratio - hence more I_d may flow —

ULTC: If the main transformer has a ULTC; this will also contribute to I_d; b/c ULTC changes the turn-ratio of the transformer, & hence the relay may receive more or less I_d. For worst case scenario, max. I_d due to an extreme position of ULTC should be considered.

Due to all these factors, a certain I_d can flow & the slope of relay should be set at a certain margin above the combined effect of these factors —

(b) Assume that this maximum start-up current = x Amps.

Then $\frac{x}{(C.T.\text{ratio}) * I_{pu}} = \frac{I}{I_{pu}}$ where $\frac{I}{I_{pu}} = ?$

Next we have to look for that value of I/I_{pu} from the graph which touches the TDS = 1 graph at time = 0.5 seconds -

from graph, this $\frac{I}{I_{pu}} \simeq 7$ -

for safety ie. to avoid relay tripping, take one step previous value

ie $\frac{I}{I_{pu}} = 6$ —

Hence,

$$\frac{I}{I_{pu}} = 6 = \frac{x}{(300/5) * 5} \Rightarrow \boxed{x = 1800\ A}$$