List of Publications

Journals [88] [89]:

- **Roy, Arpita;** Singh, Devender; Misra, Rakesh Kumar; Singh, Amit: 'Differential protection scheme for power transformers using matched wavelets', IET Generation, Transmission & amp; Distribution, 2019, DOI: 10.1049/iet-gtd.2018.6305 [SCI Indexed Journal].

- **Roy, A.**, Singh, D., & Misra, R. K.. Matched Wavelets for Differential Protection of Power Transformers Using Differential Evolution. Journal of Advanced Research in Dynamical and Control Systems in ISSN No.: 1943-023X) [Scopus Indexed Journal][Accepted for Publication].

Book Chapters:

- **Roy, Arpita**, Devender Singh, and Rakesh K. Misra. "Differential Evolution-Based Matched Wavelet for Differential Protection of Transformer." Computational Intelligence: Theories, Applications and Future DirectionsVolume II, (2019): 531. [Scopus Indexed].

Patent

- Navin Kumar, **Arpita Roy**, Devender Singh, Rakesh Kumar Mishra A SYSTEM AND METHOD FOR INRUSH AND FAULT DETECTION FOR DIFFERENTIAL PROTECTION OF TRANSFORMER, Application No. 2630/DEL/2015.

Appendix I

Derivation of Magnetizing Inrush Current

The circuit equation for the rate of change of flux (ϕ) due to alternating source voltage is given by following expression [90].

$$-\sqrt{2}E_s sin\omega t = iR_c + N\frac{d\phi}{dt}, \tag{5.1}$$

where, N is the number of turns. On integrating equation 5.1 from $-\pi/\omega$ to t, equation 5.1 becomes,

$$\sqrt{2}\frac{E_s}{\omega}(1 + cos\omega t) = \int_{\frac{-\pi}{\omega}}^{t}(iR_c + N\frac{d\phi}{dt})dt, \tag{5.2}$$

$$\frac{\sqrt{2}E_s}{\omega N}(1 + cos\omega t) = \frac{1}{N}\int_{\frac{-\pi}{\omega}}^{t} iR_C dt + (\phi - \phi_r), \tag{5.3}$$

where ϕ_r is assumed as the residual flux of the transformer, and substituting, $\frac{\sqrt{2}E_s}{\omega N} = \phi_m$

$$\phi_m(1 + cos\omega t) = (\phi - \phi_r) + \frac{1}{N}\int_{\frac{-\pi}{\omega}}^{t} iR_C dt \tag{5.4}$$

or,

$$\phi = \phi_m(1 + cos\omega t) + \phi_r - \frac{1}{N}\int_{\frac{-\pi}{\omega}}^{t} iR_C dt \tag{5.5}$$

Appendix II

Details of Hardware Components

1. Step-down Transformer
   Ratings 1 kVA, 220/110 V, 50 Hz.
   Primary side impedance: $R1 = 0.43ohm, X1 = 0.31ohm$.
   Secondary side impedance: $R2 = 1.73ohm, X2 = 1.209ohm$.

2. Nexys board used as Waveform-board: Nexys4 DDR board from Diligent. 240 DSP slices, 15850 logic slices, on chip analog-to-digital converter, 128 MB DDR2 SDRAM. 4,860 kbits of fast block RAM.
   For details visit: https://reference.digilentinc.com/reference/programmable-logic/nexys-4-ddr/reference-manual

3. Nexys video board used as Filter-board: Nexys video board from Diligent. 740 DSP slices, 33,650 logic slices, on chip analog-to-digital converter, 128 MB DDR2 SDRAM, 13 Mbits of fast block RAM.
   For details visit: https://reference.digilentinc.com/reference/programmable-logic/nexys-video/reference-manual

4. YOKINS Current Transformer (CT): ratings 50/5 A, burden 2.5 VA, Tape wound model, Class 5.0.
   For details visit: http://yokins.com/Portal/Data/Product_Doc/LXYK4H1SE4D_WQEP4YHC2

5. Data Acquisition System: NI-PXIe 1078, with 8-channel analog input module ±10 V, with 8-channel analog input module ±300 V.
   For details visit: https://www.ni.com/pdf/manuals/378197a.pdf

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