# Evaluation of Distribution System Losses and the Mitigation Using Load Balancing Prediction Model

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***Abstract-* Distribution network losses can be a result of losses in distribution transformers and distribution power lines. However, this research work investigates the evaluation of losses in a distribution network due to unbalanced loading of the distribution transformers using the Covenant university distribution system as a test network. Analysis of losses due to unbalanced loading of distribution transformers in nine (9) substations was carried out by taking real-time load readings from all three phases of the 11kV/0.415kV distribution transformers for a duration of six (6) months. The copper losses were evaluated and compared with the losses that would have occurred if the loads on the transformers were evenly distributed. The result revealed that 4% of net copper losses were incurred due to the unbalanced load conditions of the distribution transformers. Furthermore, the study carries out a mitigation method of a corrective measure for balancing the currents across the three phases. The phase balancing model was developed to evaluate the unbalanced currents, the average current across the three phases, and the deviations of the individual currents from the average currents. The aforementioned parameters were used to generate a permissible range of balanced values across the three phases. A polynomial regression model was trained using the phase balancing model to accurately predict a balanced set of currents across the three phases with an accuracy ranging from 99.55% to 99.99%.**

***Index Term-* Losses, Transformer, Distribution system, Phase Balancing. Regression model**

## 1. INTRODUCTION

After the electricity is produced, it is delivered over transmission lines to the utility's distribution networks [1]. The distribution system's goal is to provide electricity to customers in order to meet their demands [2]. However, throughout the distribution process, a considerable amount of the electricity generated by the utility is dissipated [3]. The transformers and power distribution lines are the two principal causes of losses in power distribution systems. Core losses and copper ($I^2R$) losses are the two most common forms of losses caused by these power system constituents. Since these losses result in high production costs, it is critical for electric providers to identify these losses and eliminate them in order to improve grid efficiency. Meanwhile, a significant portion, based on the loading system, of the power that a utility generates is lost in the distribution process. These losses typically account for approximately four per cent of the total system load [4].

More utilities are striving to analyze distribution transformer performance as system investment and energy prices rise. Considering the detrimental impacts of the unbalanced voltages in the networks, it is vital to analyze the propagation of imbalance via the electric power system and possible strategies and models to counteract it. A literature review of major trade publications and both national and regional technical conference proceedings was conducted to uncover current industry loss assessment. In ref. [5], the authors examined a small number of individual utility company records. Most suggested or in use distribution transformer loss assessment methodologies, according to these evaluations, are relatively similar in character. The main distinction is in the thoroughness of the assessment. A distribution transformer loss assessment approach has been created, and it is proposed for prospective industry standardization, according to the report. Regulation demand savings, on the other hand, were not included in the assessment process.

According to authors in [6], the most successful technique to decrease transmission network losses has been via the usage of transformers in practice. The report did point out, however, that transformers had their own inefficiencies. Hysteresis, ohmic resistance, and eddy currents are the three methods by which transformers lose power. The $I^2R$ losses happen in the windings, whereas the others happen in the core. The winding, or copper loss may be calculated directly from the resistance of the winding. Hysteresis and eddy currents are used to describe the core loss experienced by transformers. The research found that using transformers in the transmission system decreases $I^2R$ losses significantly, but the transformer also introduces some new factors into the loss equation.

In [7], the authors investigated the increase of power losses and derating of distribution transformers operating under unbalanced voltage and unbalanced load situations. Computer-based simulation using two and three-dimensional finite element techniques (3-D and 2 D FEM) is used to visualize magnetic fields of distribution transformers in this work. The article found that when a transformer experiences an imbalanced voltage, the flux density increases. As a result, core and copper losses rise in a transformer under these conditions. When we examine the effects of imbalance voltage and unbalance load in a transformer, we can observe that unbalanced voltage results in an increase both in copper and core loss, but unbalanced load simply increases copper loss.

Small changes in transformer losses are not significant when a single transformer is studied, but they are noteworthy when the population of transformers present in an energy distribution system is analyzed, according to the study in [8]. Bearing this in mind, the effects of unbalanced loads linked to the secondary of the transformer on transformer load losses were investigated. They came to the conclusion that a more thorough investigation and microscopic examination of financial consequences are required for better management and understanding of imbalance.

In [9], the authors underlined the need of assessing technical losses in the distribution network's economics. Unbalanced phases have an impact on the efficiency of the system, resulting in power loss and constant stress on distribution transformers. The paper provides an assessment of losses based on surveys of a selected IESCO (Islamabad electric supply corporation) distribution network in unbalanced and balanced conditions, which included different transformers with ratings of 200 KVA and 100 KVA installed in residential and small commercial areas. They finished by presenting a cost analysis as well as the yearly savings gained by reducing the loss.

According to the authors in [10], when electric power distribution systems develop in size and complexity, minimizing losses may result in significant utility savings. Other advantages of loss reduction include increased system capabilities and the ability to postpone capital expenditures for system upgrades and expansion. The research offered a MATLAB model for calculating transformer efficiency under various loading scenarios for a three-phase distribution transformer. If the correct technology is used, distribution transformers may be more efficient and cost-effective.

Authors in [11] stated that the electromagnetic losses, including core loss and copper losses, are enhanced while operating transformers under non-linear loads. As a consequence of the breakdown of the insulation, the temperature rises, lowering transformer lifespan. The rated capacity of the transformer connected to a harmonic load is frequently decreased to remedy the issue, which is known as transformer de-rating. The research then develops a novel approach for de-rating quantitative estimation based on the finite element method (FEM).

According to authors in [12], non-linear loads are the cause of harmonic current for electric utilities. The rise in electrical power losses is largely influenced by the high degree of harmonics (losses). The characteristics of power performance degradation in the transformer owing to harmonic distortion influence the quality of electric power. According to the findings, the operation of a non-linear unbalanced load might increase the losses of the transformer.

Transformers are critical components of any power system and must function effectively and reliably. Transformers are traditionally constructed for sinusoidal operation, which allows them to achieve their pre-determined life spans. Non-linear loads in power systems have expanded significantly in recent years, notably at the distribution level, resulting in non-sinusoidal current in the power system. This current raises the temperature of the transformers and consequently increases the losses.

Following the aforementioned market survey, voltage imbalance has always been a serious problem for power quality professionals owing to its effects on the load and the supply. Unbalanced line currents generate unbalanced voltage drops in the three phases of the supply system. Consequentially, the voltage system inside the supply network will become imbalanced. Voltage imbalance has diverse harmful impacts on electrical power systems, such as the rise of losses in drive systems and adjustable speed drives, additional heating, line-current unbalances, torque pulsation, mechanical strains, etc.

Thus, this study explains fully the procedure adopted for calculating the average load readings for the three phases of each transformer in the covenant university distribution used as a test network. The mathematical model used in the analysis of the copper losses due to unbalanced load is described. As a corrective measure, a model is designed to monitor the individual, currents in the red, yellow and blue phases respectively so that the system can have a more balanced set of current values across the three phases.

## 2. MATERIALS AND METHODOLOGY

The Covenant University distribution network consists of nine (9) 11kV/0.415kV substations fed from the feeder of the main 33kV/11kV injection station (gas turbine generation). The substations are namely Hostel, Library, CDS, CST, EIE, Professors' villa, New Estate, Post-Graduate (PG), and New Estate. There are a total of 13 distribution transformers in the network. The single-line diagram of the Covenant University distribution network is presented in Fig. 1.

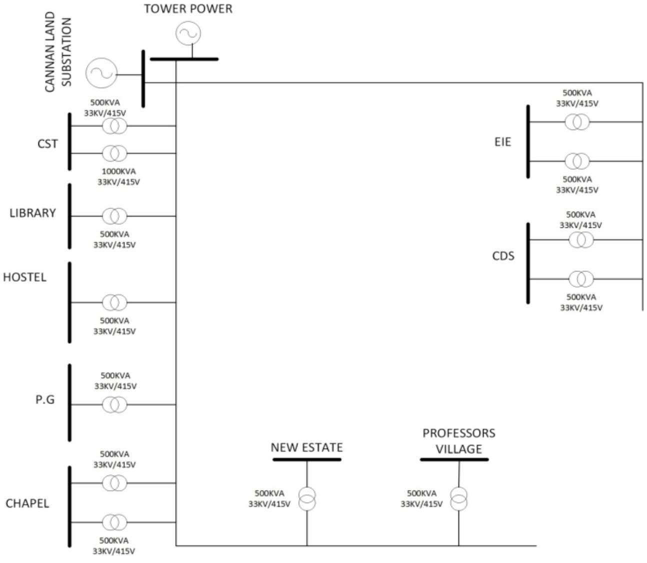

Fig. 1: Single Line Diagram of the Covenant University Distribution Network

A clamp meter was used to take real-time load readings of each phase of the distribution transformers in Covenant university network. The readings were taken from November 2021 till April 2022 (6 months). Table I shows the rating and locations of each of the distribution transformers in the Covenant University distribution network

Table I
Substation Parameters for Covenant University Distribution Network

| S/N | Substation | NoT | TR (KVA) | VR (V) |
|---|---|---|---|---|
| 1 | HOSTEL | 1 | 500 | 415 |
| 2 | LIBRARY | 1 | 500 | 415 |
| 3 | CDS | 2 | 500 | 415 |
| 4 | CST | 1 | 1000 | 415 |
|  |  | 1 | 500 | 415 |
| 5 | POST-GRADUATE | 1 | 500 | 415 |
| 6 | CHAPEL | 2 | 500 | 415 |
| 7 | PROFESSORS' VILLA | 1 | 500 | 415 |
| 8 | EIE | 2 | 500 | 415 |
| 9 | NEW ESTATE | 1 | 500 | 415 |

NoT – Number of Transformer, TR – Transformer Rating, VR – Voltage Rating

The calculated average load readings for the three phases of each transformer in the distribution network for the period under review are represented in Table II.

The copper loss in a transformer is calculated as follows:
Copper loss $= I^2R$

where
I is current in Ampere
R is resistance of the transformer winding in Ohms

However, in this study, there is another sort of copper loss caused by imbalance in a three-phase transformer.
The currents flowing in each phase of the three-phase transformer are Ir, Iy, and Ib, respectively.

Therefore,

Total load current, $I_T = I_r + I_y + I_b$

The copper loss in each phase is given by:

(i) red $= I_r^2R$
(ii) blue $= I_b^2R$
(iii) yellow $= I_y^2R$

where R is the transformer's per-phase winding resistance. As a result, total copper loss under an unbalanced load is equal to

$$I_r^2R + I_y^2R + I_b^2R = R\,(I_r^2 + I_y^2 + I_b^2)$$

For balanced condition,

$$I_r = I_y = I_b = I$$

Therefore,

$$\text{Total Copper Loss} = R\,(I^2 + I^2 + I^2) = 3I^2R$$

Therefore,

$P_{Loss}$ (due to unbalance)

$$= R\,(I_r^2 + I_y^2 + I_b^2) - 3I^2R$$
$$= R\,(I_r^2 + I_y^2 + I_b^2 - 3I^2)$$

This shows the overall net losses due to unbalanced load for a transformer. Here, the winding resistance of the transformer per phase is considered to be unity and this value is the same and constant for all the phases of the transformer independent of the loading

Table II
Substation Average Load Current

| Name Of Substation | Average Load Current (A) |  |  | Total Load Current in each Transformer (A) | Total Load Current (A) |
|---|---|---|---|---|---|
|  | Red Phase | Yellow Phase | Blue Phase |  |  |
| **Library** | 412 | 301 | 345 | 1058 | 1058 |
| **Hostel** | 530 | 383 | 421 | 1334 | 1334 |
| **CDS** | 436 | 308 | 367 | 1111 | 2535 |
|  | 405 | 549 | 470 | 1424 |  |
| **CST** | 302 | 458 | 386 | 1147 | 1582 |
|  | 178 | 140 | 117 | 435 |  |

|  |  |  |  |  |  |
|---|---|---|---|---|---|
| **Post Graduate** | 104 | 91 | 86 | 281 | 281 |
| **Chapel** | 196 | 211 | 261 | 668 | 776 |
|  | 27 | 45 | 35 | 108 |  |
| **Professors' Villa** | 142 | 107 | 99 | 348 | 348 |
| **EIE** | 166 | 257 | 205 | 627 | 878 |
|  | 82 | 76 | 93 | 251 |  |
| **New Estate** | 103 | 77 | 99 | 279 | 279 |

### 2.1 Phase Balancing Model

This model is designed to monitor the individual currents in the red, yellow and blue phases respectively of the transformer. The average current across the three phases which give a perfectly balanced system is evaluated. The system then identifies the deviation of each phase from the balanced current and evaluates the mean deviation. A range of balanced values is generated using the average current and mean deviation. The system now assigns a more balanced set of values across the three phases.

The model is mathematically expressed as follows:

Let $I_R$, $I_Y$, $I_B$, be currents in the red, yellow and blue phases respectively, therefore,

$$I_T = I_R + I_Y + I_B$$

Let $I_A$ be the average current across the three phases, hence,

$$I_A = \frac{IR + IY + IB}{3}$$

Let $\delta_R$, $\delta_Y$, $\delta_B$, be the deviation from the average in the red, yellow and blue phases respectively,

$$\delta_R = |I_R - I_A|$$

$$\delta_Y = |I_Y - I_A|$$

$$\delta_B = |I_B - I_A|$$

Let $\delta_A$ be the mean deviation,

$$\delta_A = \frac{\delta R + \delta Y + \delta B}{3}$$

Assuming a range of balanced values i.e.,

$$\text{Range} = I_A \pm \frac{\delta A}{10}$$

Balancing the phases to give $(I_A \pm \frac{\delta A}{10})_R$, $(I_A \pm \frac{\delta A}{10})_Y$, $(I_A \pm \frac{\delta A}{10})_B$ as the balanced currents in the red, yellow and blue phases respectively such that;

$$(I_A \pm \frac{\delta A}{10})_R + (I_A \pm \frac{\delta A}{10})_Y + (I_A \pm \frac{\delta A}{10})_B = I_T$$

This is the developed phase balancing model that will adjust the loads between the three phases when the imbalance exceeds the permissible limits and the computational steps involved are represented by the flowchart in Fig. 2.

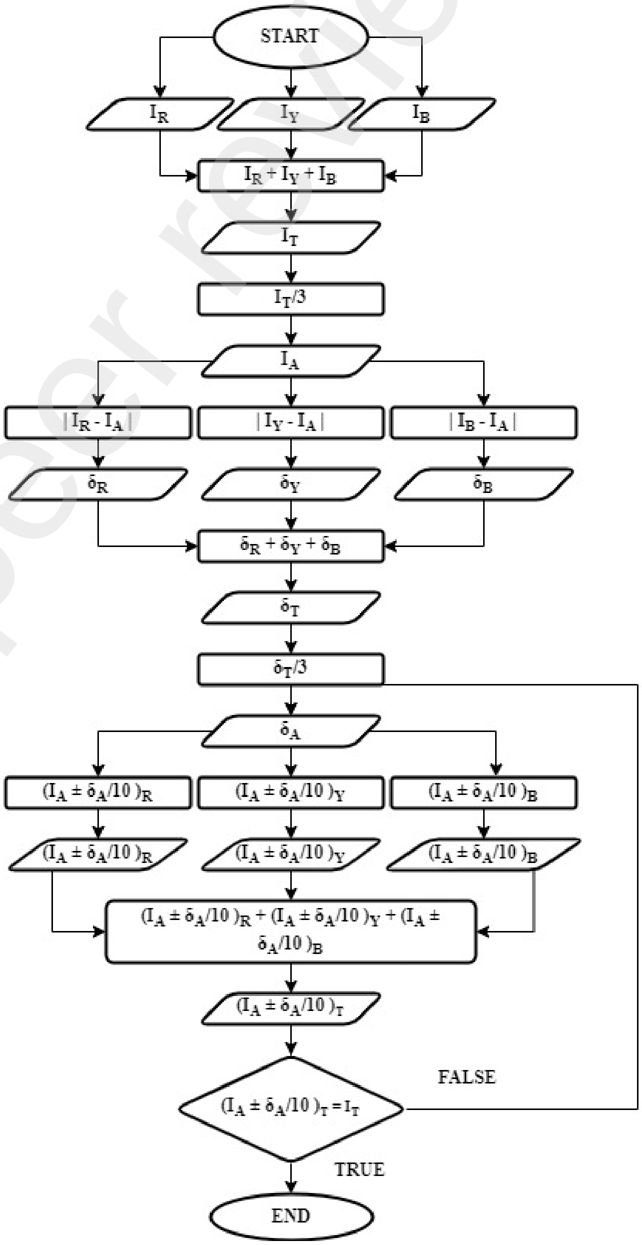

Fig. 2: Flowchart model for phase current balancing

### 3.1 Regression Model

Regression analysis is a predictive modeling technique that explores the interaction between a dependent and independent variable. The above model utilizes the correlation between the aforementioned variables to determine the best fit line or regression formula which can be used to make future predictions.

The specific approach used in this study is the polynomial regression model. Polynomial Regression is a regression approach that represents the connection between an independent and dependent variable as nth degree polynomial. It is also termed the special type of Multiple Linear Regression (MLR) because some polynomial terms are introduced to the Multiple Linear Regression equation to transform it into Polynomial Regression. It is essentially a linear model with some adjustments in order to boost the accuracy. The polynomial regression model was built using a Python code on Spyder software. The dataset utilized in Polynomial regression for training is of non-linear type. The training of the model utilized eighty percent (80%) of the dataset. The testing and prediction was done on twenty percent of the dataset (20%).

## 3.0 RESULTS AND DISCUSSION

The result from the copper losses evaluated for both unbalanced and balanced conditions using readings taken from the three phases of each distribution transformer in Covenant University distribution network are shown in Table III. Figure 3 gives a visual representation of the copper losses calculated under the unbalanced and balanced conditions.

The average load currents obtained after the polynomial regression model for phase balancing mitigation replaced the unbalanced line currents are shown in comparison with future predicted values in Table IV. A sample of the table of values for the Library substation used to generate the average current values is shown in the appendix. The table of values for the other substations were similarly used to generate their average current values respectively.

The column represented by "XTEST" comprises the unbalanced currents in each of the three phases. The column "YTEST" shows the balanced set of currents along the three phases using the regression model. The column "YPRED" shows the balanced currents predicted by the trained regression model.

Table 3: Results showing the Copper Losses for Balanced and Unbalanced conditions in the Substations

| **Name of Substation** | **Unbalanced Load Condition (Cu Losses) (W)** | | | | **Balanced Load Condition (Cu Losses) (W)** | | | **Net Loss (Units) (W)** |
|---|---|---|---|---|---|---|---|---|
| | **Red Phase** | **Yellow Phase** | **Blue Phase** | **Total** | **Per Phase Current** | **Per Phase Losses** | **Total** | |
| **Library** | 169821 | 90793 | 118953 | 379567 | 353 | 124446 | 373338 | 6229 |
| **Hostel** | 281244 | 146798 | 177014 | 605057 | 445 | 197787 | 593361 | 11695 |
| **CDS** | 189813 | 94932 | 134580 | 419325 | 370 | 137057 | 411172 | 8153 |
| | 163834 | 301118 | 221003 | 685955 | 475 | 225187 | 675560 | 10394 |
| **CST** | 91114 | 210192 | 149212 | 450519 | 382 | 146077 | 438230 | 12289 |
| | 31835 | 19551 | 13668 | 65054 | 145 | 21041 | 63122 | 1933 |
| **Post Graduate** | 10872 | 8290 | 7341 | 26503 | 94 | 8773 | 26320 | 183 |
| **Chapel** | 38341 | 44565 | 68158 | 151064 | 223 | 49578 | 148734 | 2330 |
| | 729 | 2061 | 1238 | 4027 | 36 | 1286 | 3857 | 170 |
| **Professors' Villa** | 20061 | 11522 | 9899 | 41483 | 116 | 13493 | 40478 | 1005 |
| **EIE** | 27425 | 65973 | 41948 | 135346 | 209 | 43719 | 131156 | 4190 |
| | 6750 | 5721 | 8738 | 21210 | 84 | 7016 | 21047 | 163 |
| **New Estate** | 10676 | 5988 | 9754 | 26417 | 93 | 8678 | 26034 | 384 |
| | | | | | | | **TOTAL** | **59118** |

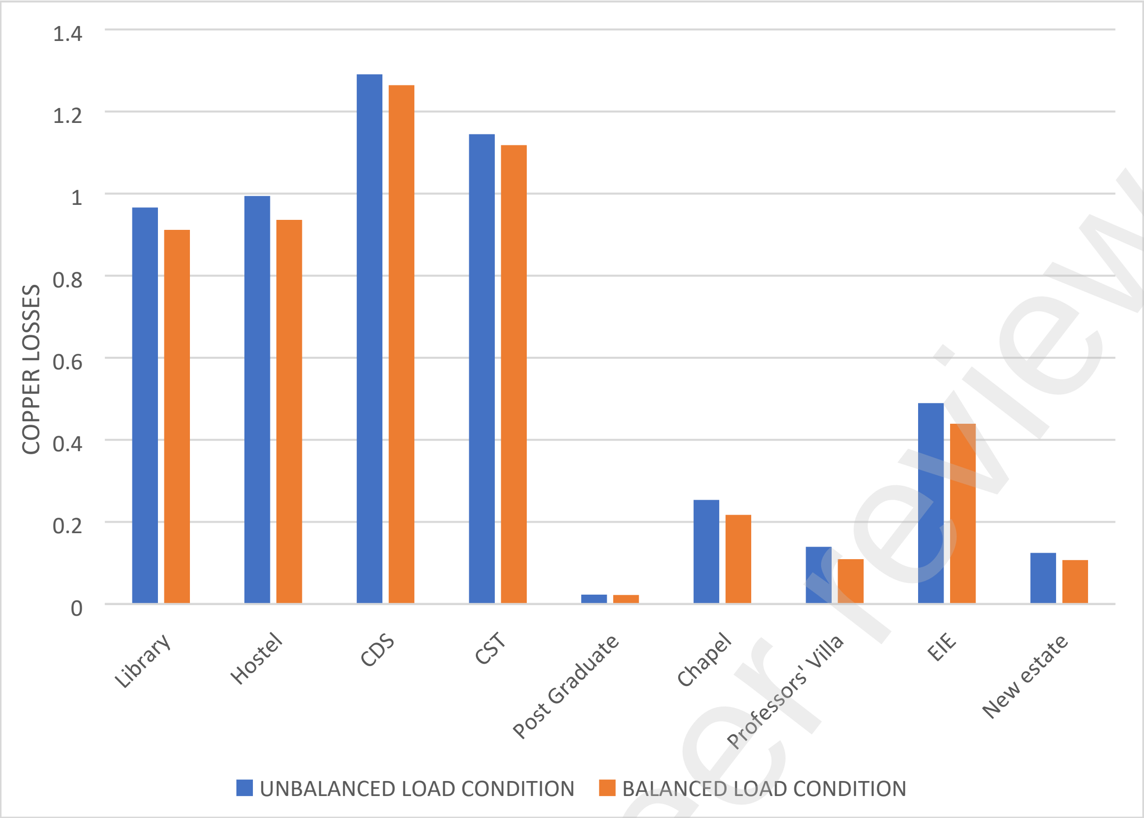

Fig. 3: Graph of Copper losses under unbalanced and balanced loads

Table IV
Average load currents after testing and prediction

| **NAME OF SUBSTATION** | **XTEST (A)** | | | **YTEST (A)** | | | **YPRED (A)** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **R** | **Y** | **B** | **R** | **Y** | **B** | **R** | **Y** | **B** |
| **LIBRARY** | 419 | 299 | 334 | 352 | 346 | 354 | 352 | 346 | 354 |
| **HOSTEL** | 528 | 374 | 406 | 435 | 438 | 437 | 435 | 438 | 437 |
| **CDS** | 839 | 858 | 837 | 845 | 844 | 844 | 845 | 844 | 844 |
| **CST** | 486 | 602 | 484 | 517 | 523 | 532 | 517 | 523 | 532 |
| **POST GRADUATE** | 104 | 90 | 86 | 94 | 93 | 93 | 94 | 93 | 93 |
| **CHAPEL** | 216 | 248 | 297 | 255 | 252 | 255 | 255 | 252 | 255 |
| **PROFESSORS' VILLA** | 137 | 107 | 99 | 117 | 116 | 110 | 116 | 116 | 111 |
| **EIE** | 253 | 333 | 299 | 299 | 294 | 292 | 299 | 294 | 292 |
| **NEW ESTATE** | 102 | 75 | 100 | 92 | 91 | 94 | 92 | 91 | 94 |

The mean accuracy of the model for each of the substation transformers are as follows:

The mean accuracy of the model for the Chapel substation transformer 1 is 99.9529%

The mean accuracy of the model for the Chapel substation transformer 2 is 99.9715%

The mean accuracy of the model for the EIE substation transformer 1is 99.9796%

The mean accuracy of the model for the EIE substation transformer 2 is 99.9111%

The mean accuracy of the model for the CDS substation transformer 1is 99.9838%

The mean accuracy of the model for the CDS substation transformer 2 is 99.9843%

The mean accuracy of the model for the CST substation transformer 1is 99.9714%

The mean accuracy of the model for the CST substation transformer 2is 99.9894%

The mean accuracy of the model for the Library substation transformer is 99.9839%

The mean accuracy of the model for the Hostel substation transformer is 99.9824%

The mean accuracy of the model for the Postgraduate substation transformer is 99.946%

The mean accuracy of the model for the Professors' Villa substation transformer is 99.5552%

The mean accuracy of the model for the New Estate substation transformer is 99.9583%

Fig. 4 presents a graphical representation of the mean accuracy of the model

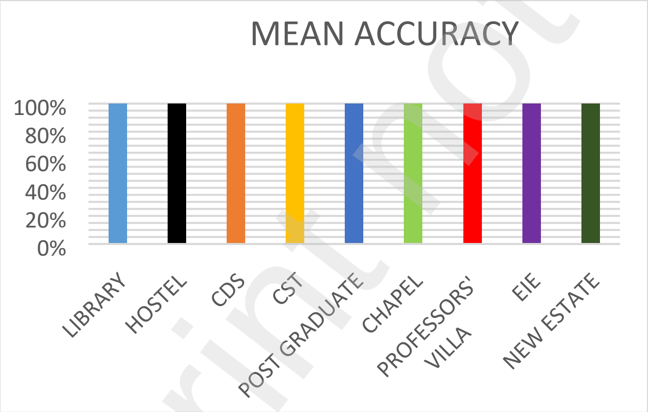

Fig. 4: Graph of the Mean Accuracies for each substation

## 5. CONCLUSION

In conclusion, unbalanced line currents generate unbalanced voltage drops in the three phases of the supply system which consequentially accrues an increase in the losses across the system. Thus, constant monitoring of the system to identify imbalance among the three phases is imperative. The polynomial regression model can effectively work with the mathematical model developed in the study to accurately identify the unbalanced line currents and predict a new range of balanced values across the three phases of the transformers with a high degree of accuracy as validated in this study. Thus, the total transformer copper losses in the network due to the loading of the distribution transformers are minimized with the steps taken to equally balance the load on all the phases of the transformers.

## ACKNOWLEDGEMENT

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## APPENDIX

| **LIBRARY** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **T1** | | | | | | | | |
| **XTEST** | | | **YTEST** | | | **YPRED** | | |
| **R** | **Y** | **B** | **R** | **Y** | **B** | **R** | **Y** | **B** |
| 420.00 | 341.00 | 407.00 | 390.33 | 386.33 | 391.34 | 390.33 | 386.35 | 391.32 |
| 413.00 | 271.00 | 282.00 | 323.88 | 316.35 | 325.77 | 323.87 | 316.38 | 325.74 |
| 431.00 | 299.00 | 317.00 | 350.70 | 343.90 | 352.40 | 350.68 | 343.95 | 352.37 |
| 403.00 | 305.00 | 353.00 | 354.69 | 350.60 | 355.71 | 354.76 | 350.38 | 355.86 |
| 421.00 | 231.00 | 294.00 | 317.52 | 308.77 | 319.71 | 317.52 | 308.76 | 319.71 |
| 390.00 | 254.00 | 330.00 | 326.13 | 320.28 | 327.59 | 326.17 | 320.16 | 327.67 |
| 404.00 | 370.00 | 372.00 | 382.46 | 380.63 | 382.91 | 382.48 | 380.55 | 382.97 |
| 423.00 | 338.00 | 360.00 | 374.69 | 370.60 | 375.71 | 374.68 | 370.62 | 375.70 |
| 451.00 | 316.00 | 307.00 | 359.93 | 352.22 | 361.85 | 359.93 | 352.22 | 361.85 |
| 415.00 | 354.00 | 307.00 | 359.83 | 355.17 | 361.00 | 359.86 | 355.08 | 361.06 |
| 439.00 | 352.00 | 400.00 | 397.93 | 394.20 | 398.86 | 398.03 | 393.91 | 399.06 |
| 433.00 | 312.00 | 301.00 | 350.41 | 343.43 | 352.16 | 350.41 | 343.45 | 352.15 |
| 420.00 | 287.00 | 270.00 | 327.62 | 319.80 | 329.58 | 327.63 | 319.78 | 329.59 |
| 446.00 | 299.00 | 301.00 | 350.68 | 342.62 | 352.70 | 350.69 | 342.59 | 352.72 |
| 433.00 | 240.00 | 264.00 | 314.83 | 304.84 | 317.33 | 314.89 | 304.65 | 317.46 |
| 377.00 | 366.00 | 317.00 | 354.09 | 351.08 | 354.84 | 354.04 | 351.22 | 354.74 |
| 430.00 | 342.00 | 443.00 | 406.30 | 401.09 | 407.61 | 406.30 | 401.10 | 407.60 |

|  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|
| 417.00 | 240.00 | 340.00 | 334.25 | 326.60 | 336.16 | 334.26 | 326.54 | 336.20 |
| 382.00 | 336.00 | 335.00 | 351.64 | 349.07 | 352.28 | 351.61 | 349.17 | 352.22 |
| 442.00 | 290.00 | 272.00 | 336.89 | 328.00 | 339.11 | 336.90 | 327.96 | 339.14 |
| 419.00 | 249.00 | 298.00 | 324.01 | 315.97 | 326.02 | 323.98 | 316.06 | 325.96 |
| 440.00 | 247.00 | 443.00 | 379.35 | 368.61 | 382.04 | 379.43 | 368.39 | 382.19 |
| 410.00 | 242.00 | 385.00 | 347.81 | 339.22 | 349.96 | 347.78 | 339.34 | 349.89 |
| 432.00 | 242.00 | 424.00 | 368.57 | 358.29 | 371.14 | 368.65 | 358.06 | 371.29 |
| 443.00 | 315.00 | 308.00 | 357.15 | 349.89 | 358.97 | 357.15 | 349.88 | 358.97 |
| 402.00 | 343.00 | 291.00 | 346.51 | 341.81 | 347.68 | 346.56 | 341.64 | 347.79 |
| 428.00 | 367.00 | 286.00 | 361.87 | 355.71 | 363.41 | 361.84 | 355.81 | 363.35 |
| 393.00 | 364.00 | 299.00 | 353.10 | 348.71 | 354.20 | 353.07 | 348.79 | 354.14 |
| 411.00 | 276.00 | 415.00 | 369.22 | 361.66 | 371.12 | 369.20 | 361.73 | 371.07 |
| 442.00 | 256.00 | 303.00 | 335.91 | 326.93 | 338.16 | 335.90 | 326.95 | 338.14 |
| 392.00 | 279.00 | 338.00 | 337.52 | 332.77 | 338.71 | 337.59 | 332.56 | 338.85 |
| 384.00 | 323.00 | 339.00 | 349.40 | 346.47 | 350.13 | 349.39 | 346.51 | 350.10 |
| 433.00 | 359.00 | 385.00 | 393.18 | 389.81 | 394.02 | 393.23 | 389.65 | 394.12 |
| 413.00 | 248.00 | 349.00 | 338.50 | 331.16 | 340.34 | 338.48 | 331.22 | 340.30 |
| 409.00 | 279.00 | 272.00 | 321.84 | 314.47 | 323.69 | 321.85 | 314.45 | 323.70 |
| 445.00 | 262.00 | 329.00 | 347.40 | 339.14 | 349.46 | 347.40 | 339.15 | 349.46 |
| 407.00 | 261.00 | 331.00 | 334.53 | 328.40 | 336.07 | 334.60 | 328.21 | 336.19 |