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AN ARTIFICIAL NEURAL NETWORK APPLICATIONS IN THE MANUFACTURING of CAST RESIN TRANSFORMERS

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ABSTRACT

In this study, prediction of deviation of calculated P_k, P_0 and U_k values from the values to be measured is done by using neural nets. For this purpose three layer feed-forward neural nets using back propagation learning algorithm is being used. We obtained an improvement for Pk ,Po and Uk with ANN prediction.

Key Words: Artificial Neural Networks, Back Propagation, Cast Resin Transformers.

1. INTRODUCTION

In power distribution, the nearer one gets to the consumer and the higher the voltage becomes, the lower are the losses in power teasmission. And the supply network becomes all the less complex. It is therefore always economical to locate transformers as near as possible to consumers or at load centers. But transformers take up space. And that is likely to be restricted in the immediate vicinity of the loads. And transformers have to be safe. Otherwise there is danger for both people and property. GETI cast resin transformers have been proving their worth as the ideal solution to this problem. For they are compact, and can therefore be fitted in almost any where . Nothing is done by halves where safety is concerned . They are versatible, both in terms of connection and of extendibility. They are economical and maintenance free . They are also environmentally compatible and fully recyclable.

GETI cast resin transformers have a long life expectancy. This problem is therefore highly unlikely to come about for a good 30 years. But nonetheless, the recyclability question can be answered already today. Standard processes can be safely applied to recover the metals from the iron core and framers (these components make up 90 % of the entire transformer) . Recycling of the cast-resin coils is likewise a purely mechanical matter and involves no burden to the environment. Pure copper and insulating material can be easily separated. The copper can then be directly recycled and the cast-resin can be safely dumped. Alternatively it can be reused as a filler.

Wherever distribution transformers installed in the immediate vicinity of people are required to meet the most stringent safety standards, GETI cast-resin transformers provide the perfect solution.

GETI transformers avoid the limitations of liquied-filled transformers while retaining their advantages. This environmentally acceptable, flexible technology permits the transformers to be installed right at the load centre .This saves cost . GETI cast-resin transformers are ideal for applications where there can be no compromises on safety in Multi-storey buildings, hospitals, road and underground railway shafts, off shore, sports stadiums, meeting halls, pumping stations, water catchment areas and mining installations, and a great deal more. They are and water catchment areas. They are also being used more frequently in industrial applications for load center substations and supply feeder stations because by using cast resin transformers there will be no civil engineering costs for oil catch pits and fire protection. This also greatly facilitates resting of the transformers should it be necessary.

The number of dry type transformers for use in buildings and industrial plants has increased in order to meet new safety requirements in the World. Well over 60 000 cast-resin transformers have proved their worth in power distribution all over the world.

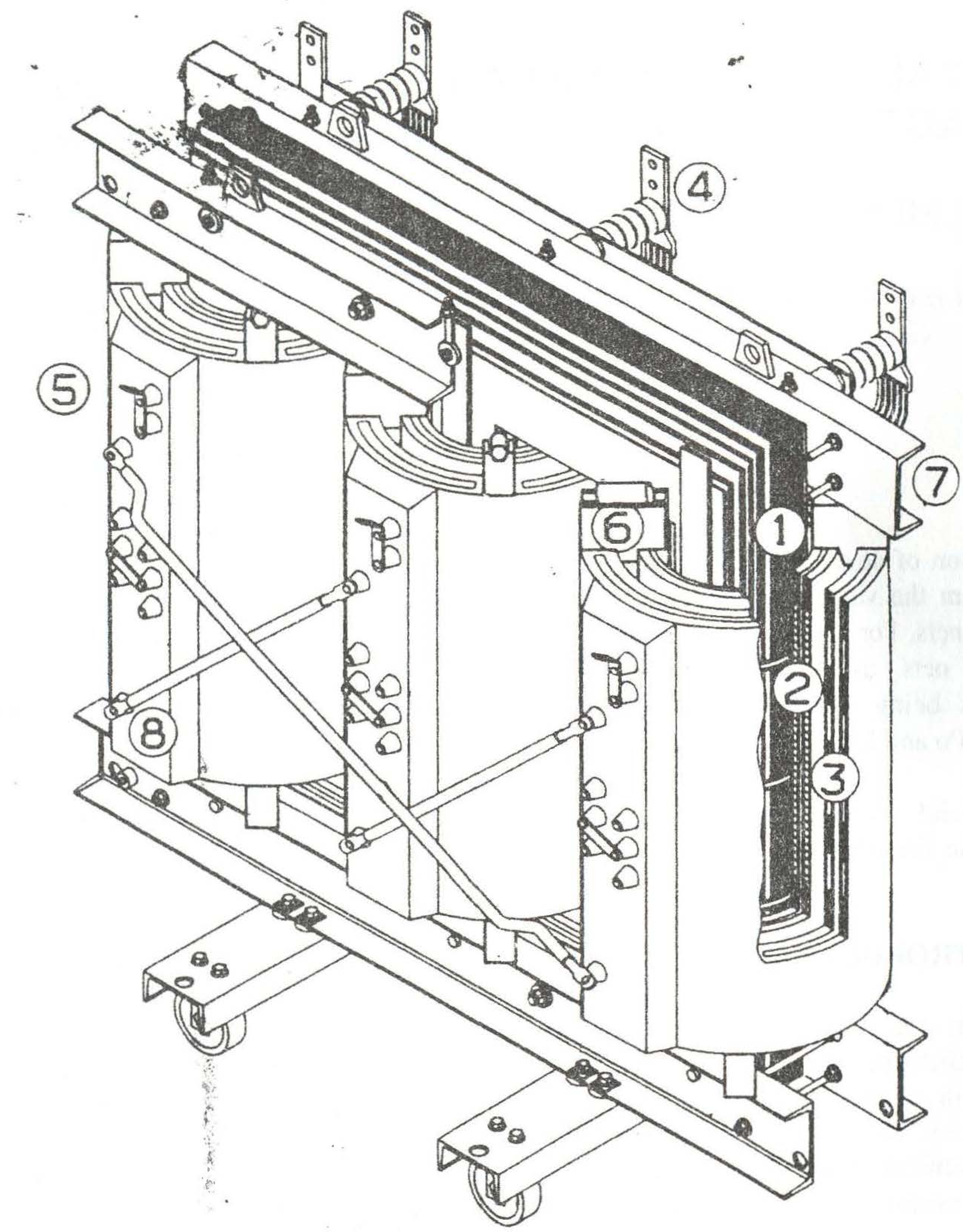

Figure 1. General structure of a GETI cast resin transformer (1-Core, 2,3-Both LV and HV winding, 4-LV terminals, 5-HV terminals and tappings, 6-Resilent spacers, 7-Yoke clamping and wheel frame, 8-Fiberglass reinforced epoxy

II. ARTIFICIAL NEURAL NETWORK

Artificial neural network (ANN) models or simply "neural nets" go by many names such as connectionist models, parallel distributed processing models, and neuromorphic system. whatever the name, all these models attempt to achieve good performance via dense interconnection of simple computational elements. In this respect, artificial neural net structure is based on our present understanding of biological nervous systems. For complex ternary mixtures and long-term measurements the artificial neural network offers advantages in predictability.

II.I ANN MODEL`S

The artificial neuron was designed to imitate the first order characteristics of the real biological neuron. Essentially a set of inputs are applied, each representing the output of another neuron. Each input is multiplied by a corresponding weight analogousto a synaptic strength, and all the weighted inputs are then summed to determine the activation level of the neuron Figure 2 depicts a model that implements the above functional description.

$$Ynet = W1\,X1 + W2\,X2 + \ldots\ldots + Wn\,Xn \quad (1)$$

Activation function used in this study is $f(x) = 1/(1+\exp(-x))$. Thus ,

$$Yout = 1/(1+\exp(-Ynet)) \quad (2)$$

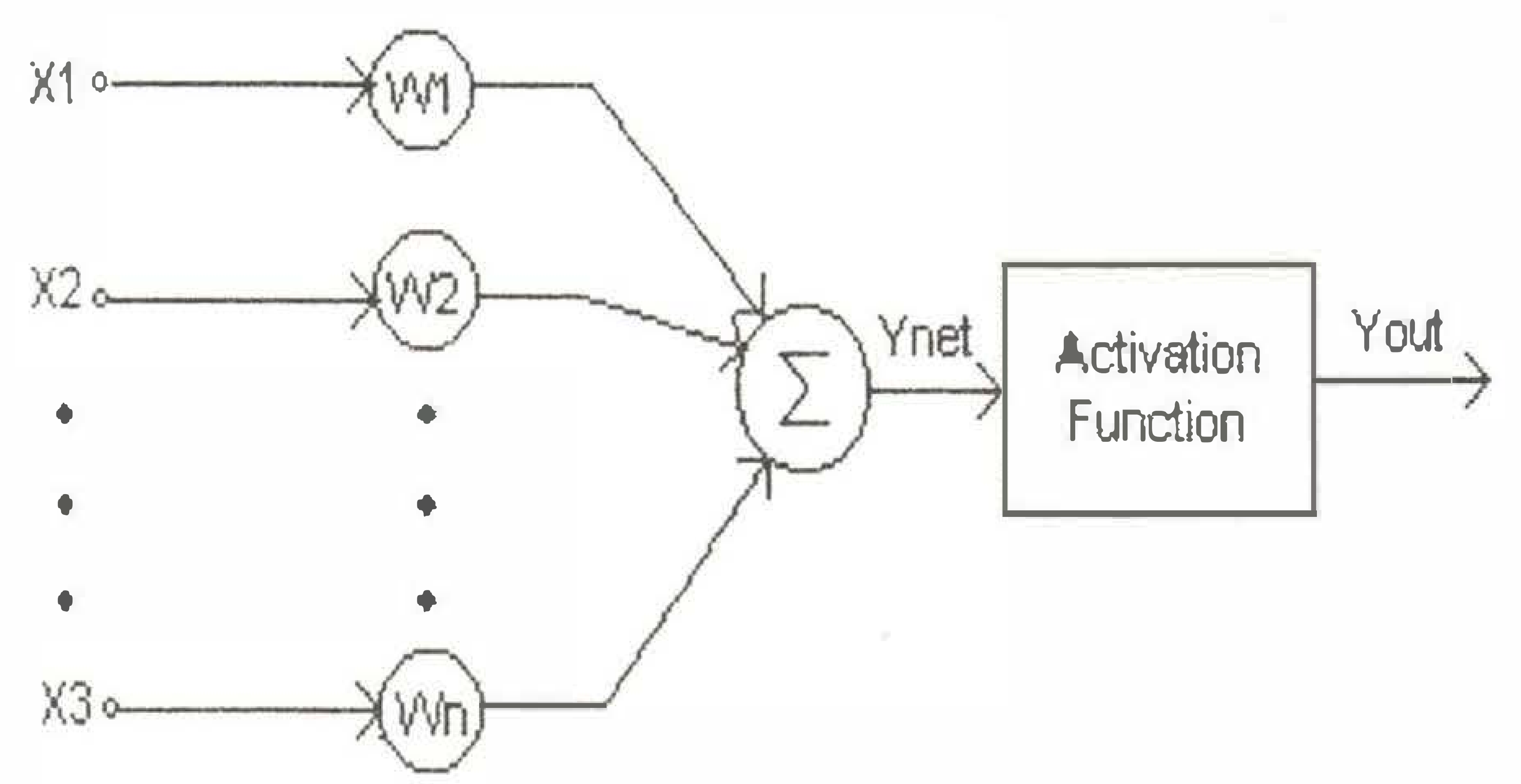

Figure 2. Artificial neuron model

III. METHOD

Because of inevitable differences in basic materials and variations in manufacture, as well as measurement errors, the values obtained on test may differ from the calculated values 1.

No-load losses (Po), short circuit losses (Pk) and impedance voltage (Uk) are the most important parameters of the transformer. Prediction of differences between calculation and test measurement values of these parameters is important for the transformer designers. Because , value of P_0 depends on core weight, that of P_k depends on conductor quantity and Uk depends on dimensions of transformer, winding voltage and frequency. That is these parameters effects directly the cost of the transformer.

For these purpose we tried to obtain the prediction of these values by using ANN. And back propagation algorithm was used for learning of ANN's. We used three layer ANN . Figure 3. shows the structure of this ANN. We used 15 hidden neuron for hidden layer, 6 neuron for input layer and 3 neuron for output layer .

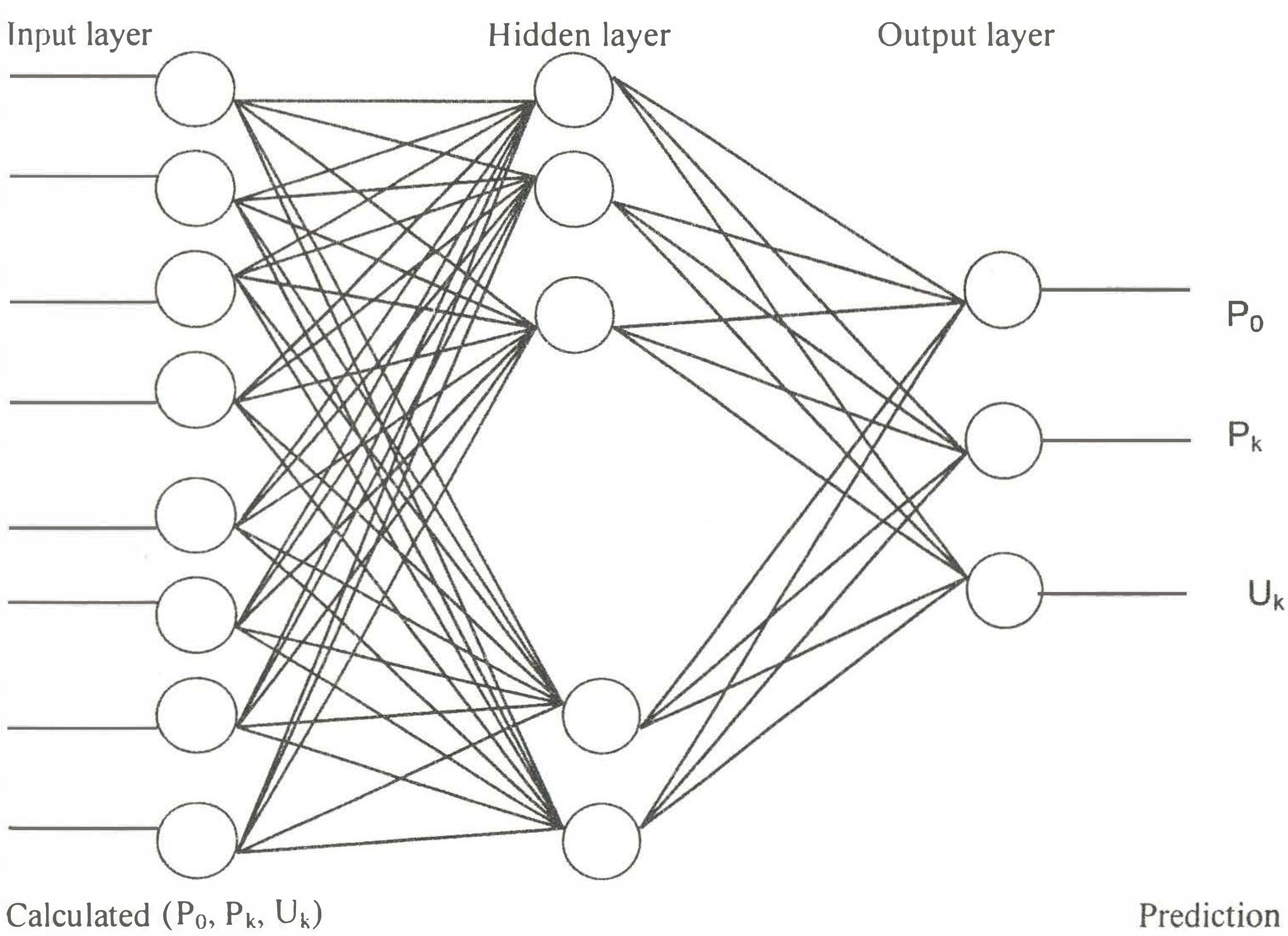

Figure 3. Structure of used ANN

In the all ANN structures learning coefficient is 0.25 and momentum coefficient is 0.75.

For the performance measurement, we use the mean

relative absolute error E(RAE);

$$E(RAE)=\frac{1}{n_{test}}\sum_{testset}\left(\frac{\left(V_{predicted}-V_{true}\right)}{V_{true}}\right) \quad \forall V_{true}\neq 0 \qquad (3)$$

and difference between the mean relative absolute errors ΔE(RAE)

$$\Delta E(RAE) = E(RAE)_{calculated} - E(RAE)_{predicted} \qquad (4)$$

Where n_{test} is number of test set , $V_{pred.}$, $V_{calc.}$ and $V_{mea.}$ are predicted , calculated and measured values respectively. The test set contains about measured values of about 50 GETI cast resin transformers. Rated Powers of these transformers were between 100 kVA and 315 kVA.

IV. RESULTS

Results of ANN learning were very well. As seen in the figure 4 , learning of ANN improved and overall E(RAE) decriesed with number of iteration.

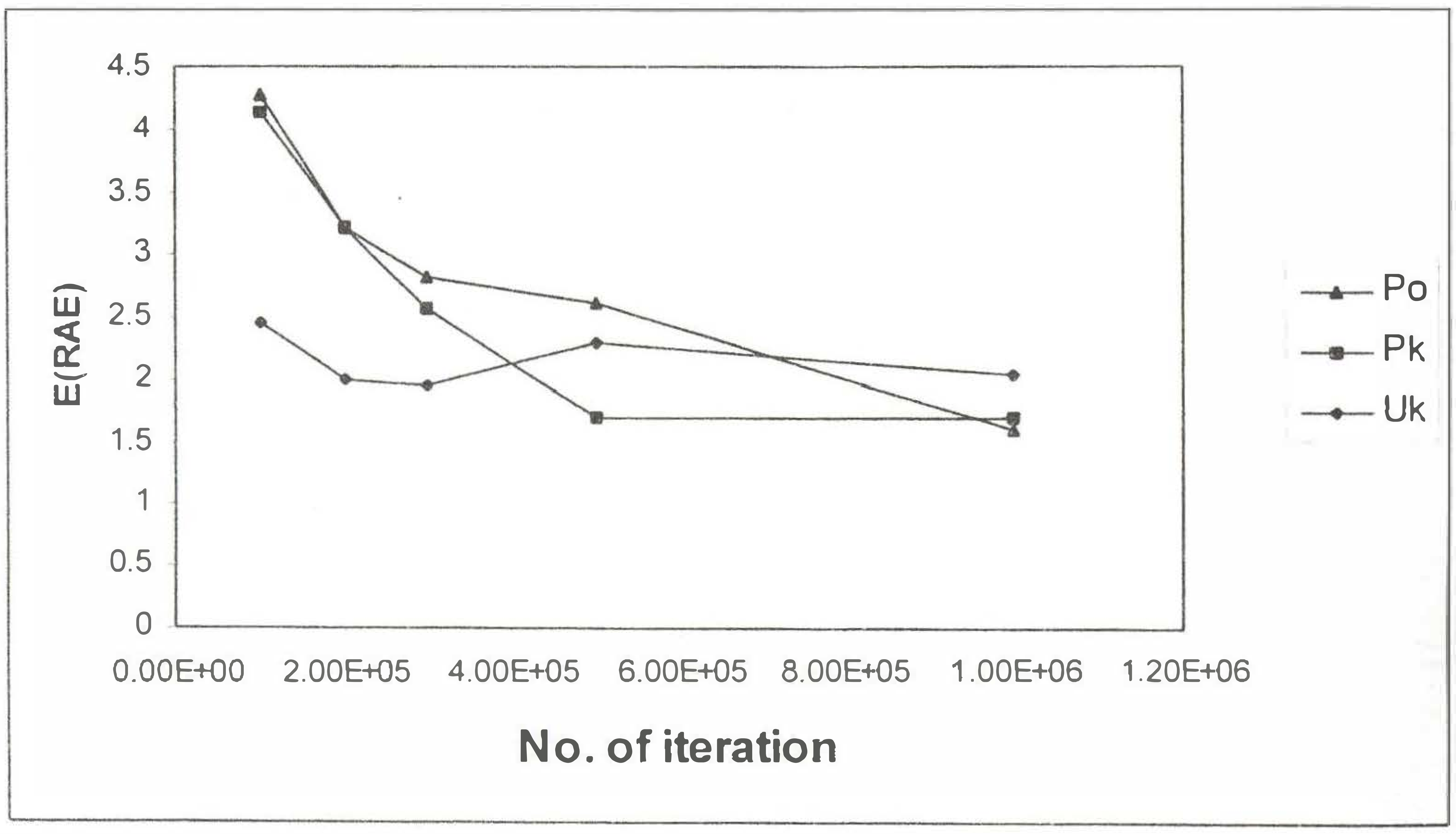

Figure 4. Results of ANN

We obtained an improvement for Pk ,Po and Uk with ANN prediction. This is important for the transformer designers and very hopeful.

	ΔE(RAE)
Po	5.8
Pk	2.7
Uk	0.41

Table 1. ΔE(RAE) for 1.00E-06 iteration

Results are useful for giving idea to the designer.

Obtained results were well, but using of this method directly we must study with all range of transformers at least 100 kVA to 3150 kVA .

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