Analysis of transformer oil for dissolved gas is a useful predictive and maintenance tool for determining the residual life of a transformer. Insulating mineral oils used in transformers contain a mixture of many hydrocarbons. These hydrocarbons decompose and liberate gases when subjected to thermal or electrical stress. The components of solid insulation also take part in the formation of gases, which dissolve in the oil. The sources of gas generation are transformer windings, loose joints, tap changers, core laminations and bushings. Excessive formation of a gas may indicate insulation deterioration. An assessment of these gases both qualitatively and quantitatively would help in diagnosing the faults in the transformer.

The Dissolved Gas Analysis (DGA) is carried out by extracting nine key gas components namely hydrogen, oxygen, nitrogen, methane, carbon monoxide, carbon dioxide, ethane, ethylene and acetylene from samples of oil taken from oil filled equipments. When analyzed on a routine basis, a failing transformer can be identified and replaced without leading to power shutdown or a serious explosion. There are various international codes and guidelines on interpreting the dissolved gases. They are (i) Roger’s Method of Diagnosis, (ii) Ratio Method as per IEC 599/CBIP, (iii) Duval’s Triangle Method and (iv) Key Gas Analysis. These methods are designed based on IEEE guidelines for the interpretation of gases generated in oil immersed transformers. It is governed by the standards given by ANSI / IEEE standard C57.104 – 1991, 1992. These are predefined powerful methods to
identify certain specific faults, whereas there is a need for an automatic diagnostic tool to determine multiple faults.

This thesis has addressed the problem of prediction and classification of faults in power transformer. Soft computing techniques like Artificial Neural Network (ANN) and Support Vector Machine classifier (SVM) are used to diagnose multiple faults in power transformer using DGA. These techniques make use of information about the six gases of the nine mentioned earlier namely, hydrogen, acetylene, ethylene, methane, ethane and carbon dioxide. A gas chromatograph is used to separate gases from the sample oil. These separated gases are identified by, a thermal conductivity detector for atmospheric gases and a flame ionization detector for hydrocarbons and oxides of carbon. A methanator is used to detect oxides of carbon by reducing them to methane when they are in very low concentration.

An artificial neural network is developed to predict the variation in the dissolved gases in a transformer. Input patterns of ANN structure are the ppm (parts per million) value of the dissolved gas data of sample oil with day’s count, collected from the electricity board of Tamil Nadu, Chennai, India. The predicted dissolved gases are obtained as output patterns for a given day count. These predicted dissolved gases are used to diagnose the fault type based on interpretation result of international standard methods. Levenberg Marquardt algorithm is used for training the network. This algorithm is a very simple and robust method for approximating a function. To confirm the goodness of fit and the statistical significance of the estimated parameters, regression analysis is done. The procedure is repeated for consecutive years,
if normal ageing is obtained as the predicted results from the regression analysis. The algorithm can be repeated for the next year with reset oil count, in case the predicted results show increase in fault gas level with oil filtration taken as remedial action.

Support Vector Machine classifier (SVM) is utilized to classify the faults based on DGA data in power transformers. Classification is achieved by realizing linear and non-linear separation surfaces in the input space according to the data base. A separate set of dissolved gas data in ppm (parts per million) with transformer condition is collected from electricity board of Tamil Nadu, Chennai, India to train the developed SVM classifier. Initially the accuracy of the diagnosis is verified by using the testing data obtained from one of the electrical engineering concern placed in Chennai, Tamil Nadu, India. Then the predicted dissolved gas data from ANN is given as a testing data to the trained SVM classifier and classification of fault is obtained as output. A comparative study is made for fault diagnosis by IEEE/IEC methods such as ratio method, roger’s method and duval triangle method using predicted DG data. It is found that SVM method is able to specifically distinguish the fault type when compared to standard methods.

A load dependent dissolved gas analysis also done using regression analysis and neural network model by reformulating the ANN structure under loaded condition with dissolved gas data. The data for this analysis is collected from six BHEL make 105 MVA, 400 kV/230 kV power transformers in a substation with corresponding break down voltages in kV and load in MW. The input patterns of the reformulated ANN are test date of
DGA, gases obtained (Hydrogen, Methane, Ethane, Ethylene, Acetylene and Carbon di Oxide), break down voltages and load. The outputs patterns of the network are break down voltages and types of fault for a given load and time period.

The findings of the thesis serve to predetermine the residual life of power transformer. The fault classification using support vector machine classifier is better compared with interpretation result of IEEE/IEC standard methods. Increase in formation of hydrogen gas is noticed whenever the load increases beyond 50 % of rated value. As per the standards, increase in hydrogen leads to thermal fault. The thermal effect in turn triggers cellulose degradation which leads to increase in acetylene gas level. These consequences finally result in arcing fault. The work presented in this thesis will be useful in predicting the type and time of occurrence of fault.