CHAPTER – I

INTRODUCTION

1.1. General

Technocrats face two practical difficulties in a process of manufacturing. To decide the process parameters values that will reach the desired product quality of goods and to increase the productivity using the available inputs. The decisions of the technocrats are generally taken on experience and expertise. But rules they follow to achieve the desired objective is also important while decision making. Surface roughness is used as main quality of goods parameter and mostly in the cases technical necessity for mechanical product. In various applications to achieve the expected surface finish is most importance for the useful performance of a product. In industry tool steel materials of high hardness are significant in various applications. For the purpose of work presented hardened tool steel materials are used for experimentation purpose [1 - 2].

1.2. Hypothesis

1. Machining process output cutting parameters are function of input cutting parameters. Prediction of output cutting parameters results into the saving in time - cost of manufacturing the product.

2. Compare different material removal processes, End milling machining or material removal process is one of the most prominent, frequently and commonly used machining processes in an industry.

3. The surface roughness is a major output parameter which demonstrates the quality of product used in evaluation process in an End Milling process.

4. The end milling input cutting parameters depth of cut, feed and speed affect the output variable significantly. Therefore the roughness of surface (Ra) will be predicted using these input cutting parameters. Prediction accuracy will
increase if other parameters affecting output are considered in prediction studies.

5. Adaptive Neuro Fuzzy inference system (ANFIS) prediction model is more reliable and accurate as compare to other conventional and advanced prediction models [2].

1.3. Aims and objectives

The aim of present work is modeling using fuzzy-inference-system (FIS) to forecast process output cutting parameters of end milling process. This is achieved with following objectives.

1. Prediction of surface roughness using the major input cutting parameter depth of cut, feed and spindle rotation for hardened die steel materials Bohler K110, Bohler K340, DC 53, AISI 1040 steel and other die steel materials. The Adaptive network based Neuro – Fuzzy inference system was used as an advanced optimization technique in prediction model. An ANFIS tool of MATLAB 7.6 will be used as a prediction and validation tool. An experimental data is collected for training and testing purpose. An experimental data is compared with prediction model and error in prediction is computed. From literature review (chapter 2) the prediction accuracy of ANFIS is better than other advanced or expert optimization techniques.

2. Work on prediction of surface roughness as with material property is not reported in literature review. Therefore effect hardness of material as an input parameter on surface roughness is studied. The experimental data is collected as in experimental setup explained in later chapter. The Adaptive network based Neuro Fuzzy inference system is used as an advanced optimization technique in prediction model. An ANFIS tool of MATLAB 7.6.0 was used as a prediction and validation tool. An experimental data was collected for training and testing purpose. An experimental data is compared with prediction model and error in prediction is computed. From literature review the prediction accuracy of ANFIS is better than other
advanced or expert optimization techniques. The mathematical correlation is proposed with input and output parameter. Validation of prediction model with mathematical and experimental results is carried out.

3. Prediction of surface roughness with step over ratio as input cutting parameter in CNC end milling process is studied with Depth of Cut, Feed, and Speed of cut as major input cutting parameters. Experimental result was compared with ANFIS prediction in MATLAB tool box. Error in prediction is computed.

4. The experimental results on CNC vertical Milling Centre for surface roughness and ANFIS prediction model is utilized to prove that the prediction accuracy will be different for each material for variable input parameters.

1.4. Factors affecting surface roughness

Deviation from the nominal surface is surface roughness. In an industry surface roughness amplitude is measured with parameter as roughness average (Ra) is used [3]. Properties work piece, properties of cutting tool, parameters of machining and way of cutting, affects the roughness surface. Factors which affect the output cutting parameter are shown in Fig. 1.1 [1]. The study of the factors ultimately results into more and more accurate result of prediction. The different combinations of these factors and studied by the researchers to optimize the input parameters and are explained in the chapter of literature review.
Cutting Phenomena

Fig. 1.1 Parameters that affect surface roughness [1]
1.5. **Organization of thesis**

In this chapter the research topic is introduced in the domain of end milling process with brief description hypothesis, aim and objectives, factors affecting the roughness of product (or goods) and their categories. In literature review chapter – II the work reported in the area of proposed research is described. This will also cover the different research methodologies adopted by the researchers with advantages and disadvantages. In review conventional and intelligent techniques used for prediction of output variable is covered. Chapter – III experimental methodology adopted with materials is explained. The succeeding chapter IV, V, VI, VII and VIII is a detailed report of the work done to achieve the aim and objectives. In these chapter results and analysis of the different materials is briefly discussed. The thesis work is summarized in chapter – IX conclusion and future scope. At the end of this thesis references which encouraged to work in this area and significantly contributed to provide the necessary information are enlisted.