Nowadays, glass fiber reinforced plastics (GFRP) composites play a vital role in many engineering applications as an alternative to various heavy exotic materials. In GFRP polymeric composites, the matrix of polymer (resin) is reinforced with glass fibers. Glass fiber reinforced plastics are increasingly used for variety of engineering applications from automobile to air craft components because of their superior advantages when compared to the other engineering materials. The advantages include weight-to-strength ratio, high fracture toughness and excellent thermal and corrosion resistance. Though the technology of composite manufacturing is advanced, near-net-shaped components with the required surface finish quality can be achieved only by machining. Surface quality and dimensional precision will greatly affect the parts during their useful life, especially in cases where the components will be in contact with other elements or materials during their useful life. Therefore, their study and characterization is extremely important.

There are significant differences between the machining of metals and alloys and that of composite materials, because composites are anisotropic and inhomogeneous in nature. Yet no special machines have been developed to machine composite materials, still traditional metal cutting tools and techniques are being used. It was appropriate to study the behavior when machining GFRP composite with different types of tools and optimization of process parameters (Ex: cutting speed, feed, depth of cut and fiber orientation angle) influencing machinability to achieve high productivity with low cost manufacturing.

Hence, in the present research work, an attempt has been made to investigate the machining characteristics of GFRP composite tubes of different fiber orientation angle varying from $30^\circ$ to $90^\circ$ in steps of $15^\circ$. An investigation was carried out to
measure the surface roughness ($R_a$), cutting force ($F_z$), Specific cutting pressure ($K_s$) and cutting power ($P$) using three different cutting tools by adopting Taguchi’s $L_{25}$ orthogonal array concept in the Design of Experiments (DOE). This investigation was set to develop and analyze a mathematical model using response surface methodology and fuzzy logic. The observed responses were optimized using genetic algorithm.

In turning of Glass fiber reinforced plastic composites, the cutting forces developed should be kept to a minimum, because an increase in the cutting force, increases the tool wear and the surfaces roughness produced will be high. For a given work piece and machine tool setup, the cutting forces and surface roughness obtained during machining are influenced by cutting parameters such as cutting speed, feed, depth of cut, etc.,

Thus, in the present work, a comprehensive analysis was carried out to study the influence of cutting speed, feed, depth of cut and fiber orientation angle on output responses like surface roughness, cutting force, specific cutting pressure and cutting power. They were measured during machining of GFRP composites. Three different types of cutting tool inserts were used in this investigation.

The GFRP composite tubes of different fiber orientation angles used in the present investigation were supplied by ICP India Private Limited, Bangalore. The tool material inserts used for this investigation were Carbide (K20), Cubic Boron Nitride (CBN), and Poly-Crystalline Diamond (PCD). All the turning operations were carried out using dry cutting conditions. A Kistler dynamometer was fitted to the experimental setup to measure the cutting force for each experiment. The surface roughness of the machined surface obtained during each experiment was measured using FORM TALY SURF surface roughness tester. At each stage of the
experimentation specific cutting pressure and cutting power were calculated. The experiments were repeated for three times and the average values are tabulated for the analysis.

After conducting the experiments, quadratic response models were developed using Response Surface Methodology (RSM) for the observed responses i.e., surface roughness, cutting force, specific cutting pressure and cutting power. These models were checked for their adequacy and significance of all the terms included in the models. Fuzzy logic, an expert system has been used for improving and validating the models. Finally, optimization was carried out to determine the optimal cutting conditions to achieve the minimum surface roughness and minimum cutting force so as to achieve better specific cutting pressure and minimum cutting power.

Except for few cases, it was found that the predicted values are in close proximity (95%) to the experimental values. This validates the model developed for the present research work. Genetic Algorithm tool in MATLAB was successfully implemented for optimization of the machining parameters. The optimized cutting conditions developed in this research work will help to achieve better machinability of GFRP composites.

The influence of cutting parameter on machining of GFRP composites has been analyzed by using graphs and microstructure analysis.

From the experimental analysis it has been observed that, the Poly Crystalline Diamond (PCD) tool produced better results among the other tools considered in this investigation.