5. Plan of Work and Methodology

A. Literature Survey:

Before starting the research work reviewed research article, journals reviews and books, also reviewed the literature of PAT Technology. Following is revealed through literature survey.

Challenges with PAT Technology

1. Part-load performance of pumps as turbines is poor.

2. The predicted data of pump as turbine performance through theoretical and numerical analysis do not match close with experimentally obtained values.

3. Selection of a good pump to be suitable as PAT is another area of challenge.


5. Overall system design where very little resource is available.

B. Developing Experimental Test Rig

Test rig will be simple in design and will provide measurements as accurate as possible. The test rig will be equipped for making measurements of net head (H), discharge (Q), torque (T) and speed (N).

C. Defining the System Hydraulic Variables

There are four important variables acting on the ‘Pump as Turbine’ control volume, which are the input variables and the output variables.

The input variables include the total head (gH) acting on the PAT and the discharge (Q) flowing through it.

The output variables include the hydraulic output power (P_{hyd}) delivered to the shaft and the speed (N) of the machine.

Other variables affecting the PAT control system

They are the geometric variables such as the outer diameter of the impeller, D, and the flow variables i.e. mass density, \( \rho \), and the dynamic viscosity, \( \mu \).
Control variables

Two of variables that control the whole system are the discharge, Q and speed, N. They are referred as control variables as changing one of the two variables the whole system can be controlled. Hence Q and N will be the parameters that will be used as reference in order to interpret hydraulic effects due to any geometric modifications considered for optimization.

The total head, gH and the hydraulic shaft power, $P_{\text{hyd.shaft}}$ will be the dependent variables.

D. Establishing functionalities between:

Discharge, Head, Power, Hydraulic efficiency

E. CFD Analysis

The pump as turbine will be divided in various flow zones and CFD analysis will be carried out.

F. Optimization

Study in following pump as turbine areas will be carried out for optimization
Inlet Impeller, Inlet Casing Rings, Suction Eye, impeller material, draft tube, penstock, generator load controller etc.

G. Experimental and CFD Correlation

The methodology of comparisons between the experimentaland the CFD results. Establishing correction factors to incorporate losses and finally present means to be able to closely predict pump performance in turbine mode.