

## Homework Assignment - 1

### AE 630

Q1. The objective is to write a computer program to implement numerical solution to the combined blade-element/momentum theory (BEMT) discussed in class. All integrations are to be performed numerically either using 1) six-point Gaussian Quadrature (if you know it or are familiar with it) or 2) simple rectangular or trapezoidal rule based numerical integration as shown in class. In the numerical solution, the blade must first be discretized into a series of small elements of equal span to perform numerical integration. Make sure that you take enough number of segments for desired accuracy (you would need to confirm it by some means e.g., by solving a simple polynomial function integration). Now for the rotor given below, plot the graph for variation of thrust vs. blade pitch angle and variation of power vs. blade pitch angle (**vary pitch angle from 0 to 16 degrees**) using the BEMT code that you have developed. Calculate total power in the following manner: Power = Profile power +  $k \times$  Induced power, where induced power factor  $k = 1.15$ .

Rotor geometry:

Blade radius,  $R = 0.355$  m

Blade chord,  $c = 0.032$  m

Number of blades,  $N_b = 2$

RPM = 1500

Density of air,  $\rho = 1.225$  kg/m<sup>3</sup>

Lift curve slope,  $Cl_\alpha = 5.73$

Drag coefficient,  $Cd_0 = 0.01$

The results obtained from simulation should be compared with the experimental measurement by using the fig files included with the assignment. Give your comments for the same.

**Note:** Those of you who have already developed BEMT code in Helicopter Theory course, you need to do the following additional task as you already have a BEMT code that you wrote. Implement a lookup table in your BEMT in which you need to find out  $Cl$  by interpolating data from a lookup table for NACA 0012 (that has  $Cl$  vs angle of attack data) which is also attached with the homework.  $Cd_0$  remains constant as before. The thrust and power calculations should use  $Cl$  from this lookup table. This is optional for those who are writing BEMT code for first time.