2.23 Hydrofoils & Propellers
Tidal Turbine Design Project
Spring 2007

Introduction:

A design project for 2.23 Hydrofoils & Propellers entails the design of a n-stream tidal tubine for extracting energy from the stream velocity in a tidal estuary. The stream flowrate varies over time, and since the estuary is fed by a freshwater river, the outgoing tide velocity is higher than the incoming tide velocity. Thus the inflow is a biased sinusoidal input. The design should including blade design , efficiency and power extraction calculations. Consideration of cavitation in the design of the blade sections must be addressed in the calculations and design (a cavitation free design is desired).

Design Specifics:

The overall specifications for the project are outlined below:

- Incoming tide maximum speed Speed 2 m/s
- Outgoing tide maximum speed 2.5 m/s
- Tidal inflow function: Biased sinusoidal
- Inflow wake velocity variation (circumferential) +/-0.3 m/s
- Turbine diameter: 6 meters
- Design depth: 5m to turbine centerline
- Rotational speed: TBD, assume gearing can match generator
- Turbine type: free tip single screw (contra-rotating design optional)
- Inflow boundary layer to be provided

Design Methods:

The following computational tool will be available for the design of the turbine:

MPVL lifting line code for matlab (similar to your own lifting code written in class) crude but very fast for parametric design. Written by Lt. Chung, a 2.23 student from last year, as his thesis from last year.

For this project some modification may be required to MPVL in order to run at negative Ct (i.e. a turbine case as opposed to a propeller case).

The lifting line codes can be used to conduct the parametric design of the propeller to determine:

- Blade number
- Initial chord distribution
- Pitch and camber
- Powering
- Efficiency

After the parametric design is complete then the sectional design of the blades can be performed using 2D data and 2D design codes. Cavitation considerations should be included here to ensure the blades to not cavitate at design conditions. At this stage the offsets for the initial blade design should be done.

Final Report:

The final report should include a description of you design process and the results from each step including plots and summarized computer outputs for you design studies.
The report is expected to be of the quality of a technical report and should be a complete description of your design process. Include plots of the turbine geometry as well as plots useful in showing the performance of the turbine.