

### Problem 295B

- (a) Consider the propeller of a boat to consist of four blades which are effectively flat plate foils each with a chord,  $c$ , and a span,  $s$ . These blades move through the water with a speed,  $V$ , due to the rotation of the propeller. They are also set such that the angle of attack of the blades relative to the water is  $\alpha$  when the boat is not moving forward. Find an expression for the thrust tending to propel the boat when it is not moving forward. Assume the simple flat plate lift coefficient for the blades. Denote the water density by  $\rho$ . The answer includes  $\alpha$ ,  $c$ ,  $s$ ,  $\rho$ , and  $V$ .
- (b) Now find the cruising speed of the boat,  $U$ , if the coefficient of drag on the hull is  $C_D$  based on a hull surface area,  $A$ , and the velocity,  $U$ . The answer contains  $\alpha$ ,  $V$ ,  $A$ ,  $c$ ,  $s$  and  $C_D$ .

Footnote: To simplify the algebra assume that  $V$  is much larger than  $U$ , and that  $\alpha$  is a small angle so that  $\sin \alpha \approx \tan \alpha \approx \alpha$ .