Unified Engineering Fall 2007
Fluids Problem 1

Part A. (70%) An average Canada Goose, which you sometimes see migrating overhead in V formations, has a wingspan of 60 in, and an average wing chord of 7 in, for a wing area of $60\,\text{in} \times 7\,\text{in} = 420\,\text{in}^2$. A typical weight is 9 lb.

a) Determine the average pressure difference $\Delta p = p_l - p_u$ between the lower and upper surfaces of the goose's wings in flight. Explain your reasoning.

b) A typical efficient lifting wing has an average lower-upper pressure coefficient difference

$$\Delta C_p \;=\; C_{p_l} - C_{p_u} \;\simeq\; 0.5 \ldots 1.5$$

We will assume $\Delta C_p = 1.0$ here. Estimate the goose's flight speed in miles per hour at sea level, and also at an altitude of 15 000 feet such as when they overfly mountain ranges.

Part B. (30% freebie if completed)

Math skills self-assessment

The objective is to establish the average UE student's understanding of material taught in the prerequisite math subjects, particularly in 18.02 or equivalent.

For each line in the table below, circle one of the 1-5 numbers using the following scale:

1 Poor understanding, or never heard of the concept
2 Weak understanding, probably couldn't apply it properly
3 OK understanding, could apply it with considerable effort
4 Good undertanding, could apply it with little or no trouble
5 Excellent understanding, almost second nature

	TOPIC OR CONCEPT	UNDERSTANDING
1	Vector addition and subtraction $\vec{u}+\vec{v}$	1 2 3 4 5
2	Scalar (Dot) product of two vectors $\vec{u}\cdot\vec{v}$	1 2 3 4 5
3	Vector (Cross) product of two vectors $\vec{u}\times\vec{v}$	1 2 3 4 5
4	Vector operations in polar coordinates r, θ	1 2 3 4 5
5	Conversion of a vector into a new coord. system $(x,y) \rightarrow (x',y')$	1 2 3 4 5
6	Normal and tangential vectors on a surface $\hat{n}$, $\hat{t}$	1 2 3 4 5
7	Gradient of a scalar field ∇p	1 2 3 4 5
8	Divergence of a vector field $\nabla\cdot\vec{v}$	1 2 3 4 5
9	Curl of a vector field $\nabla\times\vec{v}$	1 2 3 4 5
10	Line, Surface, Volume integrals $\int \vec{v}\cdot d\vec{s}$, $\iint \vec{v}\cdot\hat{n}\, dA$, $\iiint \vec{v}\, d\mathcal{V}$	1 2 3 4 5
11	Stokes Theorem $\iint (\nabla\times\vec{v})\cdot\hat{n}\, dA = \oint \vec{v}\cdot d\vec{s}$	1 2 3 4 5
12	Gauss (Divergence) Theorem $\iiint \nabla\cdot\vec{v}\, d\mathcal{V} = \oiint \vec{v}\cdot\hat{n}\, dA$	1 2 3 4 5
13	Gradient Theorem $\iiint \nabla p\, d\mathcal{V} = \oiint p\hat{n}\, dA$	1 2 3 4 5
14	Conservation of mass	1 2 3 4 5
15	Conservation of linear momentum	1 2 3 4 5
16	Conservation of angular momentum	1 2 3 4 5
17	Conservation of energy	1 2 3 4 5