AUBURN UNIVERSITY

SAMUEL GINN
COLLEGE OF ENGINEERING

AEROSPACE

AERO 4970/7970 **Fundamentals of Aeroacoustics** **SET I**

Introduction and Complex Numbers

1. Show the location in the complex plane of the following complex numbers:
   a) $7+3i$
   b) $4-2i$
   c) $-i$
   d) $5e^{i\pi/3}$
   e) $3e^{i(5\pi/8)}$

2. Write the following in exponential notation:
   a) $12+5i$
   b) $7-3i$
   c) -1
   d) $-i$
   e) $-7+3i$

3. What is the phase relationship between:
   a) $F(t)=e^{i\omega t}$ and $G(t)=e^{i(\omega t-\pi/2)}$
   b) $F(t)=ie^{i\omega t}$ and $G(t)=-e^{i\omega t}$
   c) $F(t)=-ie^{i\omega t}$ and $G(t)=\left(1+i\sqrt{3}\right)e^{i\omega t}$
   d) $F(t)=(3-4i)e^{i\omega t}$ and $G(t)=(-3+4i)e^{i\omega t}$
   e) $F(t)=-i\left(i+\sqrt{3}\right)e^{i(\omega t+\pi/6)}$ and $G(t)=-e^{i\omega t}$

4. What are the amplitudes of the $F(t)$ and $G(t)$ functions in Problem 3?

5. Note that in Problem 3 all of the functions had the same frequency. What happens if you try to describe the phase relationship of two functions with different frequencies? For example, consider $F(t)=4e^{i(\omega t+\pi/4)}$ and $G(t)=e^{i\Omega t}$ where $\omega\neq\Omega$.

6. In deriving the continuity equation it was assumed that there are no sources or sinks of fluid. What if at every point in space fluid mass is added at the rate $\rho Q(x,y,z,t)$ per unit volume of fluid. Show that the continuity equation becomes

$$\frac{\partial\rho}{\partial t}+\nabla\cdot\left(\rho\mathbf{V}\right)=\rho Q(x,y,z,t)$$