MA 325
Homework Module 1
Due July 17

1. Convert the following quantities.

   (a) 55^o (F) = (C).

   (b) 1 acre = (square meter m^2).

   (c) 2500 square foot = (square meter m^2).

   (d) 65 MPH (miles per hour) = KmPH (kilometers per hour).

   (e) 1 Gigabytes = bytes = Megabytes = Kilobytes.

   Note that in binary system, we have 1 byte = $8 = 2^3$ Bit, 1 Kilobyte = $1024 = 2^{10}$ Bytes, 1 Megabyte = $1024 = 2^{10}$ Kilobytes = $1,048,576 = 2^{20}$ Bytes, and so on.

2. The average gas price in China is \$6.17 per liter in RMB while it is \$2.10 per gallon in US on July 15, 2016. Assume that the exchange rate of one us dollar is 6.69 Chinese RMB. Where is cheaper? By how much? .

3. Are the following formulas are *dimensional* correct? If not, can you fix it?

   (a) $x = \frac{1}{2}at^2$, where x is a distance, a is an acceleration, t is time.

   (b) $V = 4\pi R^2/3$, where V is a volume, R is the radius of a sphere. What is the correct formula? What it be dimensional correct if V is the area, and R is a radius of a circle?

4. Assume that we have the following relation

$$t = h(V, \kappa, T)$$

   If we know the variables have the following dimensions

$$[t] = s, \qquad [\kappa] = m^2 s^{-1}, \qquad [T] = kgm^{-1}s^{-2},$$
$$[V] = m^3.$$

   Carry out the dimensional analysis to find relationship between t and other variables.

5. (a) The one dimensional Stokes equation has the following form

$$\rho u_t + p_x = \mu u_{xx},$$

   where ρ is the density with dimension $[\rho] = kgm^{-3}$, u is the velocity with dimension $[u] = ms^{-1}$, p is the pressure with dimension $[p] = kgm^{-1}s^{-2}$, x is a length with dimension $[x] = m$, and t is the time with dimension $[t] = s$. **Find the dimension** of μ (it is called the viscosity). Note: $u_t = \frac{\partial u}{\partial t}$, and $u_{xx} = \frac{\partial^2 u}{\partial x^2}$ and so on.

   (b) Is the equation $\rho u_t + (u_x)^2 + p_x = \mu u_{xx}$ physically correct? Why?

6. Carry out the non-dimensionalization process for the following ODE,

$$a\frac{d^2x}{dt^2} + b\frac{dx}{dt} + cx = d\,f(t),$$

where a, b, c, d are constants.

7. How long does it take to cook a chicken? It is reasonable to assume that the cooking time is

$$t = f(l, \rho, T, \kappa) \tag{1}$$

where t is the time, l is the diameter of a circular cooking pan, ρ is the density of the chicken ($[\rho] = kg\,m^{-3}$), T is the oven temperature ($[T] = kg\,m^{-1}s^{-2}$), and κ is the thermal conductivity of the chicken ($[\kappa] = m^2\,s^{-1}$).

   (a) Carry out the dimensional analysis to simplify the function relation using l, ρ, T as the primary variables.

   (b) It may be also reasonable to assume that the T, say 350^oF, ρ, and κ are constant, and $l = CM^{2/3}$, where M is the mass of the turkey. Simplify the relation further with those information.

   (c) Explore possible way to further simplify (or quantify) the function.

8. Write a summary of the Module (two page limit).