ME 2580 Dynamics  
Power and Efficiency

The work done by a force $F$ as a particle moves from position 1 to position 2 is

$$U_{1\rightarrow2} = \int_{t_i}^{t_f} F \cdot \vec{r} = \int (F \cdot \vec{v}) dt.$$  

The power generated by $F$ at any instant is $P = F \cdot \vec{v} = dU/dt$. The average power generated by $F$ over an interval of time $\Delta t$ is $P_{\text{avg}} = \Delta U/\Delta t$.

Many mechanical or electro-mechanical systems are used to supply power to (or to do work on) other systems. One common example is the electric motor. These systems must always be supplied a higher level of power than they deliver. The ratio of the power they deliver to the power they received is defined as the efficiency of the system.

$$\varepsilon = \frac{\text{power delivered}}{\text{power received}} \quad \text{(efficiency of the system)}$$

Units:

1 Joule (J) = 1 (N-m)  
1 Watt (W) = 1 (J/s) = 1 (N-m/s)  
1 Horsepower (HP) = 550 (ft-lb/s)