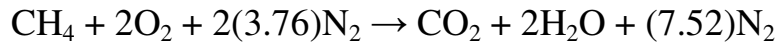# ME 417

Design of Alternative Energy Systems

Quiz #1
Closed Book, Closed Notes

A direct methane-water fuel cell operates with the following overall reaction

$$CH_4 + 2O_2 + 2(3.76)N_2 \rightarrow CO_2 + 2H_2O + (7.52)N_2$$

Determine the efficiency of this fuel cell at 298 K.

Equations and Data for Quiz #1

Enthalpy and Entropy Data

	CH_4	O_2	N_2	CO_2	H_2O
$\overline{h}_f \,(kJ/kmole)$	-74,850	0	0	-393,520	-241,820
$\overline{s}^o_{298} \,(kJ/kmole \cdot K)$	186.16	205.04	191.61	213.80	188.83

$$\overline{h} = \overline{h}_f + \Delta\overline{h}$$

$$\overline{s}_i = \overline{s}_i^o - R_u \ln(y_i) \quad \text{with } R_u = 8.314 \text{ kJ/(kmole·K)}$$

$$y_i = \frac{\nu_i}{\sum\limits_j \nu_j}$$

$$\eta_i = 1 - \frac{T_{FC}\left\{ \sum\limits_{reactants} \nu_i \overline{s}_i - \sum\limits_{products} \nu_j \overline{s}_j \right\}}{\sum\limits_{reactants} \nu_i \overline{h}_i - \sum\limits_{products} \nu_j \overline{h}_j}$$