

# ME 201

## Thermodynamics

### Final Exam

**Directions:** Work all three problems. The exam is open notes and open text book. All problems have equal weight. Note that you may round where appropriate to avoid interpolation.

#### **Problem 1**

A more realistic model for the compression process in an internal combustion uses a polytropic process followed by an isentropic process instead of a single isentropic process. The engine operates with the following conditions:

Six cylinder, four stroke engine with displacement of 2.8 liters  
Compression ratio: 9.065  
Compression ratio for polytropic process: 3  
Polytropic exponent for first compression process: 1.203  
Initial air conditions: 280 K and 120 kPa  
Engine speed of 1300 rpm

Determine

- a.) the air temperature at the end of both compression processes
- b. the heat transfer for the polytropic process
- b.) the engine power in kW for the two compression processes

#### **Problem 2**

It has been found that microwave heating of methane gas increases its combustion temperature from 2700 K to 3000 K. We wish to determine if the use of microwave heating is cost effective. Consider a power plant that is producing 1 MW of electric power as it operates with a low temperature of 290 K. The electric power sells for and costs \$0.04 per kW·hr, and the heat transfer from the high temperature reservoir costs \$0.01 per kW·hr. To achieve the 300 K increase in combustion temperature, 50 kW of electric power must be used. Determine

- (a) maximum income per year the plant can generate without the microwave heating
- (b) maximum income per year the plant can generate with the microwave heating

#### **Problem 3**

Steam enters the compressor with isentropic efficiency 0.7626 at 50°C and 0.01 MPa and exits at 800 kPa. Determine

- a.) the ideal work input (in kJ/kg) required
- b.) the actual work input (in kJ/kg) required
- c.) the exit temperature of the steam