UNIVERSITY OF CALIFORNIA **ME40/Spring 2018**
Mechanical Engineering **C. Fernandez-Pello**

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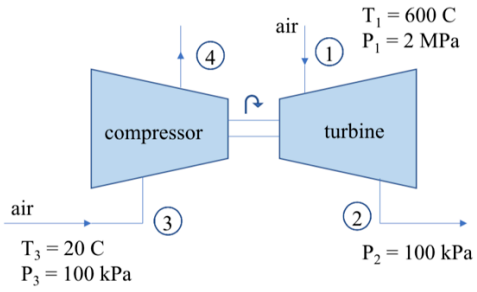
MIDTERM EXAMINATION #2 (4/6/18)

The test is closed books and notes. It consists of two problems graded as 70% the first problem and 30% the second. Please write your name in the space provided above.

1. The turbocharger of a Diesel engine consists of a turbine/compressor unit as shown in the figure. The turbine extracts work from the engine exhaust gas and transfer it to the compressor, which in turn uses it to increase the pressure of the air entering the engine. The engine exhaust gas flowing through the turbine can be considered to be air. The air enters the turbine at 600 C, and 2 MPa and exits the turbine at 100 kPa. The air enters the compressor at 20 C and 100 KPa. The turbine and compressor are insulated so that they operate adiabatically and are rigidly connected so that there are no losses in the transfer of work from the turbine to the compressor. The kinetic and potential energy through the turbine and compressor can be neglected. The turbine has an isentropic efficiency of 90%, and the compressor has an isentropic efficiency of 80%. **Note**: for air use constant Cp=1 kJ/kg.K ; Cv=0.72 kJ/kg.K ; k=1.4. **Reminder** Tds = du + Pdv = dh – vdP.

Answer the following questions:

(a) What's the temperature of the air at the turbine exit, in K ?
(b) What's the entropy change of the air and the entropy generation in the turbine, in kJ/kg K ?
(c) What's the temperature of the air at the compressor exit, in K ?
(d) What's the pressure of the air at the compressor exit, in kPa ?
(e) What's the entropy change of the air and the entropy generation in the compressor, in kJ/kg K ?



2. Consider the turbine in a hydroelectric power plant, that operates with liquid water from a dam. The liquid water enter the turbine at 20 C, and with a velocity of 6 m/sec, and exits the turbine with a velocity of 0.5 m/sec. The potential energy through the turbine can be neglected. The turbine can be considered as adiabatic and it has an isentropic efficiency of 95 %. Calculate the power provided by the turbine.
Note: for liquid water use constant C=4.18 kJ/kg.K. **Reminder** Tds = du + Pdv= dh - vdP