

CONCORDIA UNIVERSITY
FACULTY OF ENGINEERING AND COMPUTER SCIENCE
DEPARTMENT OF MECHANICAL ENGINEERING

Student's Name: _____

I.D.: _____

PROBLEM I [40 pt]

Carbon dioxide contained in a piston-cylinder device is compressed from 0.3 to 0.1 m³. During the process, the pressure and the volume are related by $P = a V^{-2}$, where $a = 8 \text{ kPa m}^6$.

- Plot the process on a P-v diagram.
- Calculate the work done on the carbon dioxide during this process.

PROBLEM II [40 pt]

Air is compressed from 101.325 kPa and 17°C to a pressure of 1000 kPa while being cooled at a rate of 25 kJ/kg by circulating water through the compressor casing. The volume flow rate of the air at the inlet conditions is 142 m³/min, and the power input to the compressor is 522 kW. Determine:

- a- The mass flow rate of the air in kg/s.
- b- The temperature at the compressor exit.

PROBLEM III [20 pt]

- Explain physically why C_p is higher than C_v for an ideal gas?
- Express mathematically the variation of pressure with depth for an ideal gas.
- Show under which conditions, the total heat provided to a gas in a piston-cylinder assembly is converted into work?

CONSTANTS FOR AIR

$R = 0.287 \text{ kJ/kg K}$

$C_v = 0.7195 \text{ kJ/kg K}$

$C_p = 1.0065 \text{ kJ/kg K}$