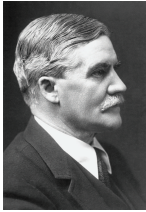


NAME:
 AME 20231
 Thermodynamics
 Examination 2
 Prof. J. M. Powers
 31 March 2010



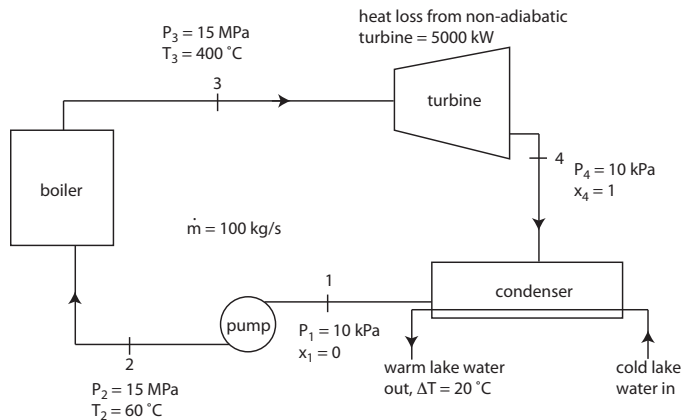
Happy 156th birthday, Sir Dugald Clerk,
 inventor of the two-stroke engine,
 b. 31 March 1854.

1. (25) A calorically imperfect ideal gas, with gas constant R and initially at P_1, T_1, V_1 , fills a cylinder which is capped by a frictionless mobile piston. The gas is heated until $V = V_2$. The specific heat is given by

$$c_v(T) = c_{vo} + \alpha T,$$

where c_{vo} and α are constants. Find the final temperature and the heat transferred to the gas in terms of given quantities.

2. (25) A sphere of aluminum with radius of 0.01 m is initially at 1500 K . It is suddenly immersed in a very large tub of water at 300 K . The heat transfer coefficient is $h = 10\text{ kW/m}^2/\text{K}$. Assuming the sphere has a spatially uniform temperature and constant material properties, find the time when the sphere's temperature is 400 K .
3. (50) Consider the Rankine cycle below. Find



- (a) the heat transfer rate to the boiler (kW),
 (b) the power output of the turbine (kW),
 (c) the overall thermal efficiency,
 (d) the thermal efficiency of a Carnot cycle operating between the same temperature limits,
 (e) an accurate sketch of the cycle on a $T - s$ diagram,
 (f) the mass flow rate of external lake cooling water to exchange heat with the condenser if the lake cooling water temperature rise is designed to be $20\text{ }^\circ\text{C}$.