1. Calculating entropy generation, state whether the following cycles are reversible, irreversible or impossible.

2-A reversible refrigerator cycle R and an irreversible refrigerator cycle I operate between the same two reservoirs \( T_H, T_L \) and each removes \( Q_L \) from the cold reservoir. The net work input required by the irreversible refrigerator cycle I is \( 70kJ \) and the net work input required by the reversible refrigerator cycle R is \( 60kJ \). If the temperature of the high temperature reservoir is \( T_H = 300K \) calculate the entropy generation for the irreversible refrigerator cycle I.

3-A cyclic heat engine operating between an energy source at constant temperature \( T_i = 900K \), and a reservoir at \( T_o = 300K \) produces half as much work as the energy extracted from the source.

a) How much entropy is generated by the engine per unit of energy extracted from source?

b) If the engine operates between the same source as in part (a) and a reservoir \( 150K \), and generates the same amount of entropy per unit of energy extracted from
the source as in part (a), what is the work output of the engine per unit of energy extracted from the source?

4- Answer the followings true or false. Explain why.

a) The process that violates the second law of thermodynamics violates the first law of thermodynamics.
b) When a net mouth of work is done by a closed system undergoing an internally reversible process, a net heat transfer to the system occurs.
c) One corollary of the second law of thermodynamics states that the change in entropy of a closed system must be greater than zero or equal to zero.
d) A closed system can experience an increase in entropy only when there is energy transfer by heat to the system during the process.
e) Entropy is generated in every internally reversible process of a closed system.
f) If there is no change in entropy between two state of a closed system the process is necessarily adiabatic and internally reversible.
g) The energy of an isolated system must remain constant, but the entropy can only increase.

5. Two equal masses \((m)\) of the same liquid initially at temperatures \(T_1\) and \(T_2\) are mixed adiabatically. Prove that the chance of entropy is positive. The specific heat of the liquid is \(C\)

6-A closed system undergoes a process in which the work done on the system is 5kJ and the heat transfer \(Q\) occurs only at temperature \(T_s\). For each case, determine whether the entropy change of the system is positive, negative, zero or indeterminate.

A-internally reversible process, \(Q = +5kJ\)
B-internally reversible process, \(Q = 0\)
C-externally reversible process, \(Q = -5kJ\)
D-Internally irreversible process, \(Q = +5kJ\)
E-Internally irreversible process, \(Q = 0\)
F-Internally irreversible process, \(Q = -5kJ\)
During steady-state operation, a parallel-shaft gearbox receives 600\(kW\) through the high-speed shaft, but owing to friction and other irreversibilities, delivers 588\(kW\) through the low-speed shaft. The gearbox is cooled on its surface according to

\[ \dot{Q} = -hA(T_s - T_0) \]

where \(h\) is heat transfer coefficient, \(A\) is the outer surface area, \(T_s\) is the uniform temperature of the outer surface and \(T_0\) is the temperature of the environment. Calculate the entropy generation for a) the gearbox as the system and b) an enlarged system consisting of gearbox and enough its surrounding that heat transfer occurs at temperature \(T_0\). Assume that \(h = 0.17\ kW/m^2 K\), \(A = 1.8 m^2\), and \(T_0 = 293 K\).