Minor 2 (MCL142), Semester 2, 2017-2018

Time: 1 hour 10 minutes	Full marks: 26
Venue: LH 114	Date: 26/03/2018

Instructions: *Answer* ***Question 1*** *(compulsory) and* ***any one*** *of question 2 or question 3,* ***but not both.*** *If you try out both question 2 and 3, you* ***must strike out*** *the attempt which you do not desire to be considered. Only the* ***first two*** *valid answers* ***(and not best two)*** *in the order of appearance in your answer-script will be graded. All parts of the same question must be placed together in your answer-script, e.g. your answer to 1(b) cannot be placed immediately after your answer to 3(d). Else, a penalty of two marks apply. Clearly mention the part number such as 3(b) at the beginning of your attempt, failing which a one-mark penalty may be imposed. A penalty of one mark applies for submitting an untidy answer-script.*

Question 1.

a) Air enters an adiabatic turbine steadily at 300 kPa, 200°C and leaves at 100 kPa and 155°C. You can take C_p of air to have an approximately constant value of 1.02 kJ/kg/K for this temperature range. Take the ratio of specific heats to be 1.4. Calculate the isentropic efficiency of the turbine. Make suitable assumptions and state them as and where they are made.

b) Calculate the final temperature of air at 300 kPa, 200°C that enters an insulated evacuated bottle using suitable assumptions. You can take properties of air as in part (a) above. Show your steps.

c) Isentropic steady flow occurs through an adiabatic compressor. Kinetic and potential energy at inlet and exits to the compressor can be neglected. Show how the compressor work can be calculated graphically in a **P-v diagram** and in an **h-s diagram**. Briefly but clearly explain your graphical answers. No explanation, no marks.

d) State Fourier's law of heat conduction (in differential form) and define all quantities therein.

(6+4+4+2)

Question 2.

A reversible engine works between three thermal reservoirs, A, B and C. The engine absorbs an equal amount of heat from the thermal reservoirs A and B kept at temperature T_A and T_B respectively and rejects heat to the thermal reservoir C kept at temperature T_C. The efficiency of this engine is f times the efficiency of the reversible engine, which works between the two reservoirs A and C. Find an expression for the ratio $\frac{T_A}{T_B}$ in terms of f and the ratio $\frac{T_A}{T_C}$. There is no part/step/process marking to this question.

(10)

Question 3.

Provide brief answer to (a)-(f) in less than equal to two sentences (excluding equations and diagrams). Penalty may be imposed for wordiness and irrelevant content.

a) State the Clausius inequality.
b) What is the Clausius statement of the second law?
c) What is the primary purpose of reheat in a vapor power cycle?
d) Explain why devices made of materials with negative temperature coefficient of specific electrical resistance are prone to thermal runaway.
e) How does the product Tv^{γ} change in an adiabatic (but not necessarily isentropic) process executed by an ideal gas which has temperature-independent specific heat?
f) State an application of the Brayton cycle.

(1+2+1+2+3+1=10)