

Instructions to candidates

Duration: Two (02) hours
Number of questions: Four (04)
Mark allocation: 100 marks
Answer all questions

1.

- a. Describe the difference between an open system, a closed system and an isolated system.
(Maximum word limit is 200)
- b. Briefly explain the zeroth law of thermodynamics (Maximum word limit is 150)
- c. Briefly explain the adiabatic process and state two approximated real world examples for the adiabatic process. (Maximum word limit is 200)
- d. Briefly describe the following terms.
 - i. State
 - ii. Process
 - iii. Cycle.
 - iv. Quasi-static process

(25 Marks)

2.

- a. State the 1st law of thermodynamics,
 - i. Use a formula to express the 1st law of thermodynamics with usual notation.
 - ii. State the sign convention of the 1st law of thermodynamics.
 - iii. Define the thermal efficiency of a heat engine.
- b. What are the stages involved in carnot cycle ?
Explain them using a schematic diagram and a PV diagram.
- c. Define tons of refrigeration.

(25 Marks)



3. A geothermal power plant uses geothermal water extracted at $160\text{ }^{\circ}\text{C}$ at a rate of 440 kg/s as the heat source and produces 22 MW of net power. If the environment temperature is $25\text{ }^{\circ}\text{C}$, determine
- The actual thermal efficiency,
 - The maximum possible thermal efficiency,
 - The actual rate of heat rejection from this power plant
- (25 Marks)**

4. A commercial refrigerator with refrigerant-134a as the working fluid is used to keep the refrigerated space at $30\text{ }^{\circ}\text{C}$, by rejecting its waste heat to cooling water that enters the condenser at $18\text{ }^{\circ}\text{C}$ at a rate of 0.25 kg/s and leaves at $26\text{ }^{\circ}\text{C}$. The refrigerant enters the condenser at 1.2 MPa and $65\text{ }^{\circ}\text{C}$ and leaves at $42\text{ }^{\circ}\text{C}$. The inlet state of the compressor is 60 kPa and $34\text{ }^{\circ}\text{C}$ and the compressor is estimated to gain a net heat of 450 W from the surroundings. Determine
- The quality of the refrigerant at the evaporator inlet.
 - The refrigeration load,
 - The COP of the refrigerator (define what you mean by COP)
 - The theoretical maximum refrigeration load for the same power input

(25 Marks)