

Instructions to candidates

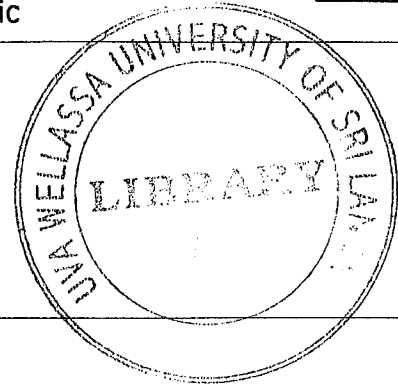
Duration: One (01) hour

Number of questions: Four (04) Essay Questions

Mark allocation: 100

Answer all questions

Use thermodynamic property tables if needed



1. A certain quantity of air at a pressure of 1 bar and temperature of 70°C is compressed adiabatically until the pressure is 7 bar in Otto cycle engine. 465 kJ of heat per kg of air is now added at constant volume. Using $c_p = 1.0$ kJ/kg K, $c_v = 0.706$ kJ/kg K for air, show each operation on p-V and T-s diagrams and determine:

- a. Compression ratio of the engine. (6 marks)
- b. Temperature at the end of compression. (6 marks)
- c. Temperature at the end of heat addition. (6 marks)
- d. Thermal efficiency of the cycle (7 marks)

(Note: For an adiabatic process from 1 to 2 we can write $P_1 V_1^K = P_2 V_2^K$, K is specific heat ratio)

2. A gas-turbine power plant operating on an ideal Brayton cycle has a pressure ratio of 8.5. The gas temperature is 320 K at the compressor inlet and 1360 K at the turbine inlet. Utilizing the air-standard assumptions, determine:

- a. The gas temperature at the exits of the compressor and the turbine (10 marks)
- b. The back work ratio (10 marks)
- c. The thermal efficiency (5 marks)

3. A steam power plant operates on a theoretical reheat cycle. Steam at boiler at 15 Mpa , 550°C expands through the high pressure turbine. It is reheated at a constant pressure of 4 Mpa to 550°C and expands through the low pressure turbine to a condenser at 10 Kpa. Draw t-s and h-s diagrams and find,
- a. Quality of steam at turbine exhaust (8 marks)
 - b. Cycle efficiency (12 marks)
 - c. Steam rate in kg/kWh (5 marks)
4. Refrigerant 134a is the working fluid in an ideal vapor-compression refrigeration cycle that communicates thermally with a cold region at -10°C and a warm region at 20°C. Saturated vapor enters the compressor at -10°C and saturated liquid leaves the condenser at 20°C. The mass flow rate of the refrigerant is 0.08 kg/s. Determine,
- a. The compressor power, in kW (10 marks)
 - b. The refrigeration capacity, in kW. (10 marks)
 - c. The coefficient of performance. (5 marks)

