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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(TAKE HOME)
SEMESTER I
SESSION 2020/2021

COURSE NAME	:	PROCESS THERMODYNAMICS
COURSE CODE	:	BNL 30203
PROGRAMME CODE	:	BNL
EXAMINATION DATE	:	JANUARY/FEBRUARY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

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Q1 (a) Consider a steam power plant that operates on a simple ideal Rankine cycle as shown in **Figure Q1 (a)**. Steam enters the turbine at 10 MPa and 500°C and is cooled in the condenser at a pressure of 10 kPa.

(i) Outline the cycle on a T-*s* diagram with respect to saturation lines.

(3 marks)

(ii) Analyze the quality of the steam at the turbine exit.

(6 marks)

(iii) Calculate the thermal efficiency of the cycle.

(3 marks)

(b) Referring to the **Figure Q1 (a)**, both pump and turbine are now is assume to have an isentropic efficiency of 85%. The steam enters the turbine at 10 MPa and 500°C and is cooled in the condenser at a pressure of 10 kPa

(i) Generalize the isentropic cycle on a T-*s* diagram with respect to saturation lines.

(3 marks)

(ii) Analyze the isentropic quality of the steam at the turbine exit.

(7 marks)

(iii) Calculate the isentropic thermal efficiency of the cycle.

(3 marks)

Q2 (a) Describe **FOUR (4)** processes to make up the simple ideal Brayton cycle.

(4 marks)

(b) Consider an ideal gas-turbine cycle with two stages of compression and two stages of expansion as shown in **Figure Q2 (b)**. The pressure ratio across each stage of the compressor and turbine is 3. The air enters each stage of the compressor at 300 K and each stage of the turbine at 1200 K.

(i) Generalize the Brayton cycle on a *T-s* diagram.

(4 marks)

(ii) Analyze the back work ratio of the cycle without regenerator and with regenerator of 75 percent effectiveness.

(12 marks)

(iii) Solve the thermal efficiency of the cycle, without regenerator and with regenerator of 75 percent effectiveness.

(5 marks)

Q3 (a) **Figure Q3 (a)** show a 300 kJ/min refrigeration system that operates on an ideal vapor-compression refrigeration cycle with refrigerant-134a as the working fluid. The refrigerant enters the compressor as saturated vapor at 140 kPa and is compressed to 800 kPa.

(i) Analyze the quality of the refrigerant at the end of the throttling process. (9 marks)

(ii) Calculate the Coefficient of Performance (COP). (3 marks)

(iii) Calculate the power input to the compressor. (3 marks)

(b) Referring to the **Figure Q3 (a)**, now the compressor is assume to have an isentropic efficiency of 85%.

(i) Generalize the isentropic cycle on a T-s diagram with respect to saturation lines. (4 marks)

(ii) Examine the quality of the refrigerant at the end of the throttling process. (6 marks)

Q4 (a) According to the **Figure Q4 (a),** n-Butane fuel (C_4H_{10}) is burned with a 100 percent excess air.

(i) Classify the mole fractions of each product. (8 marks)

(ii) Calculate the mass of carbon dioxide in the products per unit mass of the fuel. (2 marks)

(iii) Solve the air-fuel ratio. (2 marks)

(b) According to the **Figure Q4 (b),** a gaseous mixture of 30 percent (by mole fraction) methane and 70 percent carbon dioxide is heated at 1 atm pressure up to 1200 K. The natural logarithm of the equilibrium constant for the reaction at 1200 K is 4.147. Analyze the equilibrium composition (by mole fraction) of the resulting mixtures. (13 marks)

-END OF QUESTIONS –

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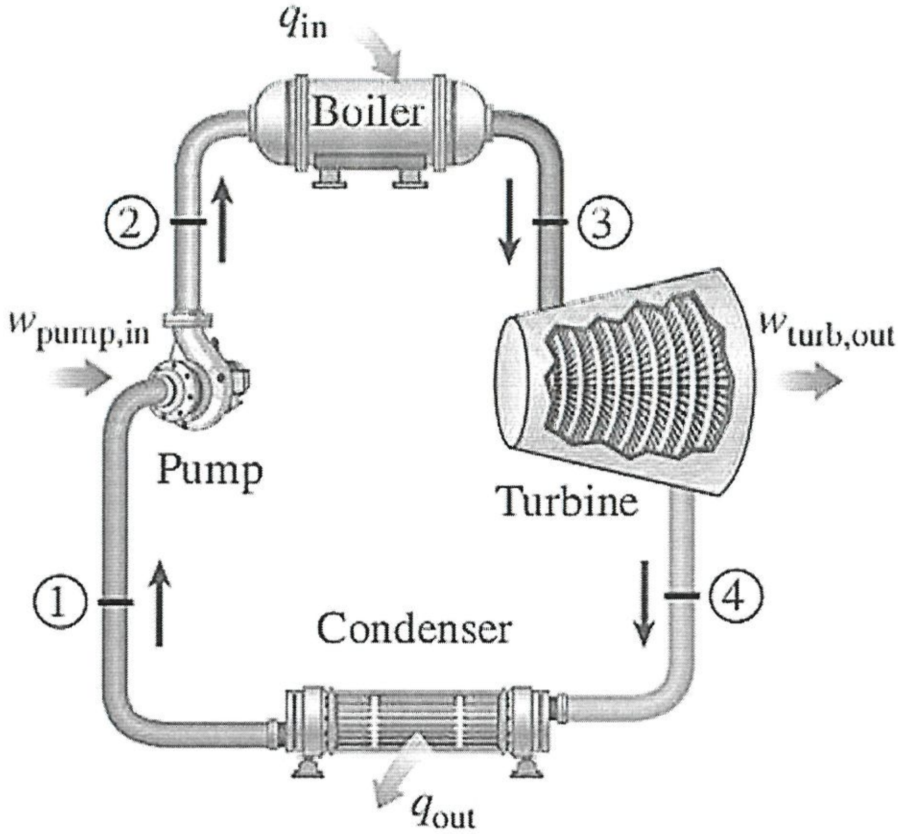

Figure Q1 (a) : Steam power plant that operates on a simple ideal Rankine cycle

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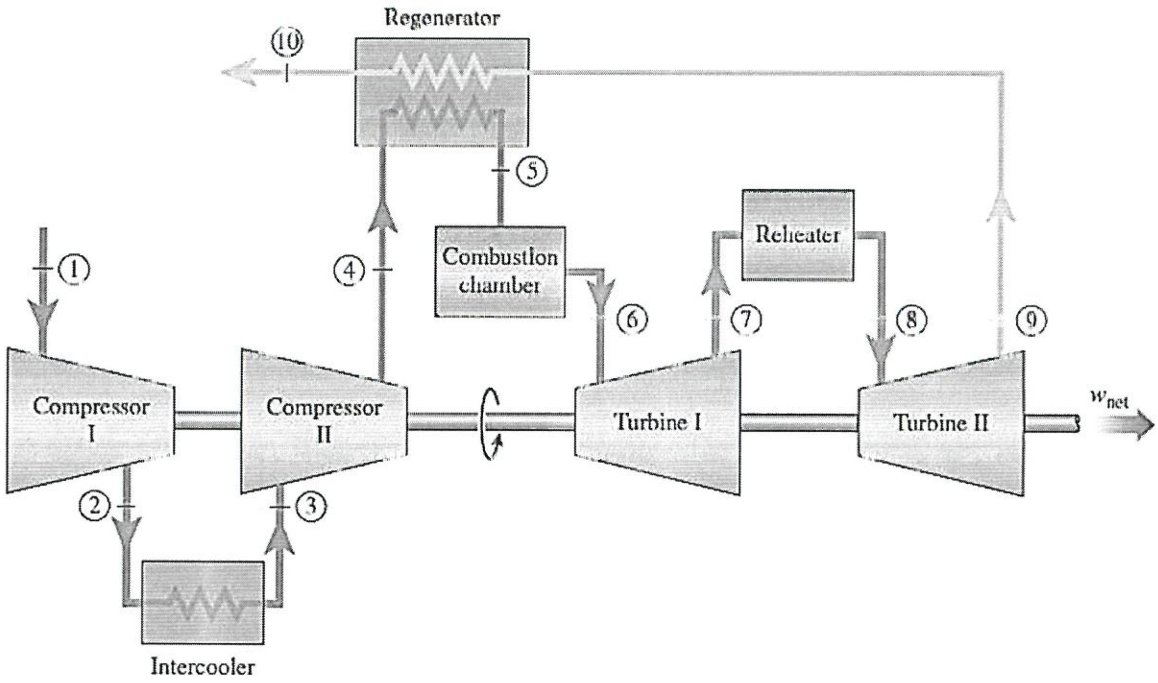

Figure Q2 (b) : Ideal gas-turbine cycle

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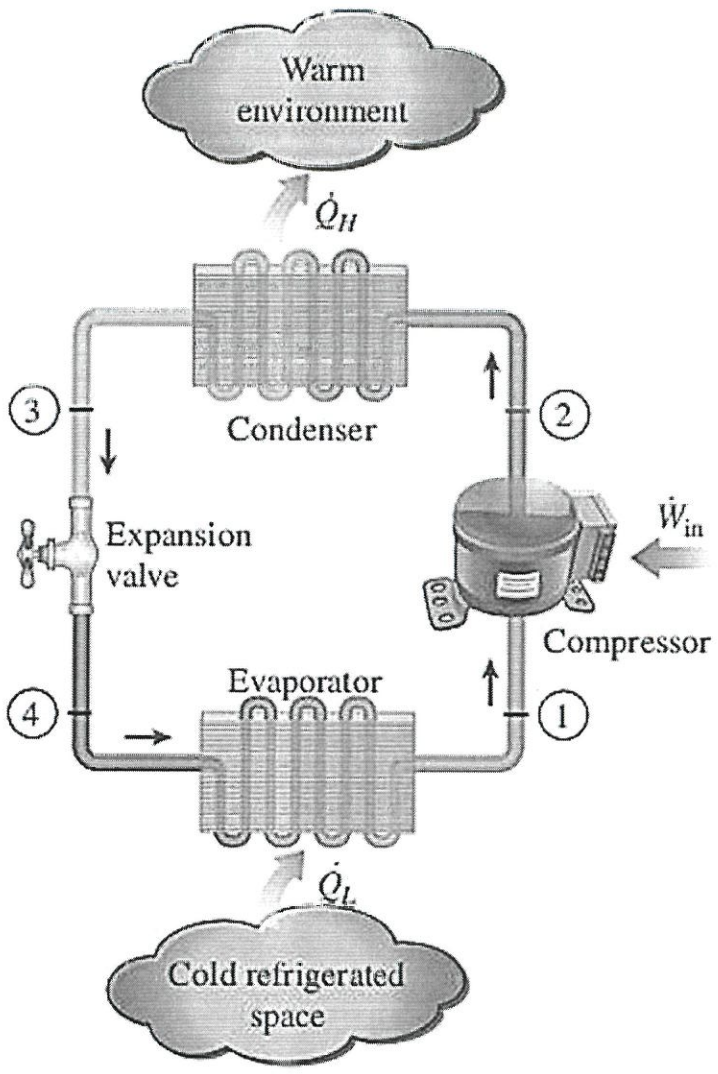


Figure Q3 (a) : Refrigeration system

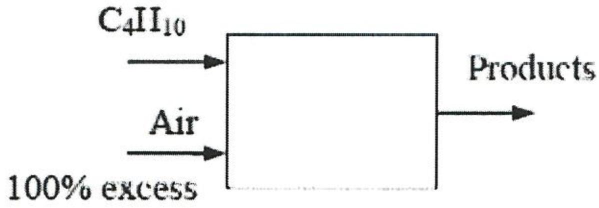
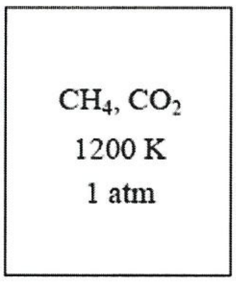


Figure Q4 (a) : Combustion flow of n-Butane



$$CH_4 \Leftrightarrow C + 2H_2$$

Figure Q4 (b) : Equilibrium constant for ideal gas mixture