Index no: .....

UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 1 Examination in Engineering: December 2023

Module Number: ME1202

Module Name: Fundamentals of Thermodynamics (C-23)

PART A

[90 minutes]

Instructions for candidates

- Write your index number on top of every page.
- Question paper consist of **17** multiple choice questions.
- From question number **01 to 10 carries 01 mark** for each question and from question number **11 to 17 carries 02 marks** for each question.
- Answer all questions. Each question has only one answer.
- **For each question, select the correct answer and put an X mark on the letter (a), (b), (c) or (d), by using a blue pen.**

01. What are the intensive properties of a thermodynamic system?
    a) Mass and internal energy
    b) Volume and enthalpy
    c) Enthalpy and entropy
    d) Boiling point and melting point

02. A system changes its state from one equilibrium state to another equilibrium state, then the path of successive states through which the system has passed. This kind of process is known as;
    a) Steady flow process
    b) Non-flow process
    c) Non-steady flow process
    d) Thermodynamic process

03. "A thermodynamic process in which there is no heat transfer from in or out of the system" is known as;
    a) Isothermal process
    b) Isochoric process
    c) Isobaric process
    d) Adiabatic process

04. In a heating process the temperature of a system goes up by 22.2 °C. Express this increase in temperature in Kelvin (K).
    a) 250.8
    b) - 22.2
    c) 295.2
    d) 22.2

05. Two bodies one with thermometer reading in Celsius and the other with thermometer reading in Kelvin, are in thermal equilibrium with the same system. What is the temperature of the system if both thermometers indicate the same numerical value?
    a) 91 K
    b) - 136.5 K

c) 136.5 °C

d) -136.5 °C

06. Select the correct statement.

a) The thermal efficiency of an irreversible power cycle is always equal to the thermal efficiency of a reversible power cycle when each operates between the same two thermal reservoirs

b) The thermal efficiency of an irreversible power cycle is always greater than the thermal efficiency of a reversible power cycle when each operates between the same two thermal reservoirs

c) The thermal efficiency of a reversible power cycle is less than the thermal efficiency of an irreversible power cycle when each operates between the same two thermal reservoirs

d) The thermal efficiency of an irreversible power cycle is always less than the thermal efficiency of a reversible power cycle when each operates between the same two thermal reservoirs

07. A power cycle operates between hot and cold thermal reservoirs at 2000 °F and 1000 °F, respectively. If the thermal efficiency of the power cycle is 45%, its mode of operation is;

a) reversible

b) cannot be determined with the data provided

c) irreversible

d) impossible

08. The major reason for internal irreversibility within a gearbox is;

a) chemical reaction

b) unrestrained expansion of a gas

c) mixing

d) friction

09. For a closed system, entropy;

a) may be produced within the system

b) may remain constant throughout the system

c) may be transferred across its boundary

d) all of the above

10. Under some conditions all three phases of a pure substance can coexist in equilibrium. On P-v or T-v diagrams, these triple phase states form as;

a) critical line

b) critical point

c) triple point

d) triple line

11. A power cycle operating between hot and cold reservoirs at 500 K and 300 K, respectively, receives 1000 kJ by heat transfer from the hot reservoir. The magnitude of the energy discharged by heat transfer to the cold reservoir must satisfy;

a) $Q_C \geq 600$ kJ

b) $Q_C < 600$ kJ

c) $Q_C = 600$ kJ

d) $Q_C \leq 600$ kJ

12. During steady-state operation, a gearbox receives 120 kW through the input shaft and delivers power through the output shaft. For the gearbox as the system, the rate of energy transfer by convection is $\dot{Q} = -hA(T_b - T_f)$ where $h = 0.171$ kW/m^{2}K is the heat

transfer coefficient, $A = 1.5\ m^2$ is the outer surface area of the gearbox, $T_b = 400$ K is the temperature at the outer surface, and $T_f = 393$ K is the temperature of the surrounding air away from the immediate vicinity of the gearbox. For the gearbox, calculate the heat transfer rate and the power delivered through the output shaft.

a) - 1.2 kW and - 58.8 kW
b) + 1.2 kW and + 58.8 kW
c) - 1.2 kW and +58.8 kW
d) +1.2 kW and - 58.8 kW

13. A silicon chip measuring 5 mm on a side and 1 mm in thickness is embedded in a ceramic substrate. At steady state, the chip has an electrical power input of 0.225 W. The top surface of the chip is exposed to a coolant whose temperature is 20 °C. The heat transfer coefficient for convection between the chip and the coolant is 150 W/m^2K. If heat transfer by conduction between the chip and the substrate is negligible determine the surface temperature of the chip, in K.

a) 80
b) - 353
c) 353
d) - 80

14. A rigid tank contains 3 kg of water as saturated liquid-vapour mixture at 80 °C. If 2 kg of water is in the liquid form and the rest in the vapour form, determine the partial pressure of the mixture and the volume of the tank.

a) 47.41 Pa and 3.407 m^3
b) 47.59 kPa and 3.423 m^3
c) 47.41 kPa and 3.407 m^3
d) 47.59 Pa and 3.423 m^3

15. A barometer reads 101.3 kPa at the base of a mountain. If the barometer reads 80 kPa at the top of the mountain, determine the height of the mountain assuming the average density of air to be 1.21 kg/m^3.

a) 6746.5 m
b) 8542.8 m
c) 1796.3 m
d) 1760.3 m

16. A cylindrical tank of length 30 m and diameter 1.5 m contains 25 kg of air. Determine the specific volume and density of the air in the tank.

a) 0.472 kg/m^3 and 2.12 m^3/kg
b) 0.472 m^3/kg and 2.12 kg/m^3
c) 2.12 m^3/kg and 0.472 kg/m^3
d) 2.12 $kg/m^3$and 0.472 m^3/kg

17. A gas flows through a passage of cross-sectional area 8.5 cm^2 at the rate of 0.55 kg/s. If the specific volume of the gas is 4.3 m^3/kg, determine the flow velocity.

a) 0.9197 m/s
b) 9197 m/s
c) 2782.35 m/s
d) 0.2782 m/s