10 JUL 2024

KATHMANDU UNIVERSITY
End Semester Examination [C]
June/July 2024

Marks Scored:

Level : B.E./B.Tech.
Year : II

Course : MEEG 207
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 20

10 JUL 2024

Registration No.:

Date :

SECTION "A"
[20Q. × 1 = 20 marks]

Choose and encircle the most appropriate option from each set of choices. Steam tables are allowed.

1. Which of the following quantities is not the property of the system
   a. pressure b. temperature c. specific volume d. heat

2. Pressure reaches a value of absolute zero
   a. at a temperature of - 273 K
   b. under vacuum condition
   c. at the earth's centre
   d. when molecular momentum of system becomes zero

3. Thermodynamic work is the product of
   a. two intensive properties
   b. two extensive properties
   c. an intensive property and change in an extensive property
   d. an extensive property and change in an intensive property

4. A 3-m^3 rigid tank contains nitrogen gas at 500 kPa and 300 K. Now heat is transferred to the nitrogen in the tank and the pressure of nitrogen rises to 800 kPa. The work done during this process is
   a. 500 kJ b. 1500 kJ c. 0 kJ d. 900 kJ

5. General gas equation is
   a. PV=nRT b. PV=mRT c. PV = C d. PV=KiRT

6. A 3-m^3 rigid vessel contains steam at 2 MPa and 500°C. The mass of the steam is
   a. 13 kg b. 17 kg c. 22 kg d. 28 kg

7. Saturation temperature _____ with the increase in pressure.
   a. increases b. decreases c. remains constant d. cannot be related

8. Which one of the following is correct? The cyclic integral of $(\delta Q - \delta W)$ for a process is
   a. positive b. negative c. Zero d. unpredictable

9. A closed system undergoes a process 1-2 for which the values of $Q_{1\text{-}2}$ and $W_{1\text{-}2}$ are +20 kJ and +50 kJ, respectively. If the system is returned to state, 1, and $Q_{2\text{-}1}$ is -10 kJ, what is the value of the work $W_{2\text{-}1}$?
   a. + 20 kJ b. -40 kJ c. - 80 kJ d. + 40 kJ

10. A gas is compressed in a cylinder by a movable piston to a volume one-half of its original volume. During the process, 300 kJ heat left the gas and the internal energy remained same. What is the work done on the gas?
a. 100 kNm b. 150 kNm c. 200 kNm d. 300 kNm

11. Which law states that the internal energy of a gas is a function of temperature
a. Charles' law b. Joule's law c. Regnault's law d. Boyle's law

12. Change in enthalpy of a system is the heat supplied at
a. constant pressure b. constant temperature
c. constant volume d. constant entropy

13. What is the area under the curve on a temperature –entropy diagram?
a. Heat b. work c. entropy d. volume

14. Kelvin-Planck's law deals with
a. conservation of work b. conservation of heat
c. conversion of heat into work d. conversion of work into heat

15. The compression ratio for petrol engines is
a. 3 to 6 b. 5 to 8 c. 15 to 20 d. 20 to 30

16. Otto cycle efficiency is higher than Diesel cycle efficiency for the same compression ratio and heat input because in Otto cycle
a. combustion is at constant volume
b. expansion and compression are isentropic
c. maximum temperature is higher
d. heat rejection is lower

17. The efficiency of Diesel cycle depends upon
a. temperature limits b. pressure ratio
c. compression ratio d. cut-off ratio and compression ratio

18. Mean effective pressure is obtained if the work done is divided by
a. total volume b. swept volume c. clearance volume d. compression ratio

19. In a vapor compression refrigeration cycle refrigerant leaving the compressor enters into
a. expansion valve b. evaporator c. condenser d. liquid receiver

20. In a refrigeration cycle throttling process is carried out on
a. an expansion valve b. an evaporator
c. a condenser d. a liquid receiver

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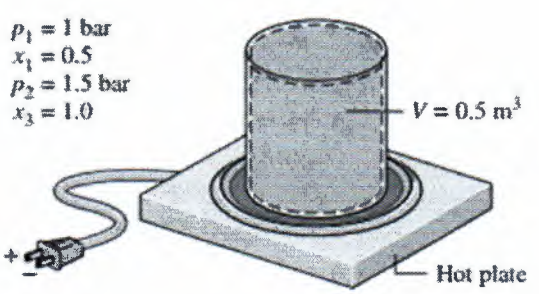
SECTION "B"

Attempt *ALL* questions. Assume suitable data if necessary. **Steam tables are allowed**.

1. a. Provide a comprehensive description of a thermodynamic system and its various types, emphasizing real-world examples. [3]
   b. Convert the following readings of pressure into kPa. [3]
      a. 40 cm Hg vacuum
      b. 90 cm Hg guage
      c. 1.2 m of water guage

2. a. Define heat transfer. Mention sign convention used for heat transfer in thermodynamics. [2]
   b. A mass of 1.5 kg of air is compressed in a quasi-static process from 0.1 MPa to 0.7 MPa for which pv = constant. The initial density of air is 1.16 kg/m^3. Find the work done by the piston to compress the air. [3]

3. a. Derive an expression for specific volume of a two-phase mixture in terms of quality. [3]
   b. A closed, rigid container of volume 0.5 m^3 is placed on a hot plate. Initially, the container holds a two-phase mixture of saturated liquid water and saturated water vapor at p_1 = 1 bar with a quality of 0.5. After heating, the pressure in the container is p_2 = 1.5 bar. Indicate the initial and final states on a T–v diagram, and determine [5]
      a. the temperature, in ^{0}C, at states 1 and 2.
      b. the mass of vapor present at states 1 and 2, in kg.
      c. If heating continues, determine the pressure, in bar, when the container holds only saturated vapor.



4. a. A piston cylinder machine contains a fluid system which passes through a complete cycle of four processes. During a cycle the sum if all heat transfer is -170 kJ. The system completes 100 cycles per minute. Complete the following table showing the method for each item and compute the net rate of work output in kW. [5]

Process	Q (kJ/min)	W (kJ/min)	dU (kJ/min)
A-B	0	2170	-
B-C	21000	0	-
C-D	-2100	-	-36600
D-A	-	-	-

P.T.O.

b. Write down the general expression for conservation of energy of a control volume applying First law of thermodynamics. Apply it for steady flow devices: turbine, nozzle and throttling valve with appropriate assumptions. [4]

5. a. Explain the limitations of the first law of thermodynamics with examples. [3]
   b. Show that the isentropic process of an incompressible substance is also isothermal. [4]
   c. Air enters a gas turbine at 1 MPa and 1500 K and exits at 100 kPa. If its isentropic efficiency is 80%, determine the turbine exit temperature. [4]

6. a. Explain working principle of an ideal Otto cycle. Sketch the cycle on P - v and T - s diagrams and derive an expression for its efficiency in terms of compression ratio. [4]
   b. Illustrate how the actual vapor power cycle differs from the ideal Rankine cycle? Describe the concept of isentropic efficiency for pumps and turbines. [4]

OR

Explain working principle of a vapour compression refrigeration cycle. Sketch the cycle on P - h and T - s diagrams. Also derive an expression for its COP when it is used as
(a) heat pump, and
(b) a refrigerator.

c. An ideal Brayton cycle has pressure ratio of 10. The temperature of air at compressor and turbine inlets are 300 K and 1200 K respectively. Determine its thermal efficiency and the mass flow rate of air required to produce net power output of 800 MW. [4]

7. Write short notes on (*ANY TWO*): [4]
   a. Heat Engine and its Thermal Efficiency
   b. Critical point
   c. Exergy