

KATHMANDU UNIVERSITY
End Semester Examination
May/June, 2022

Marks Scored:

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

Course : MEEG 207
Semester : II

Exam Roll No. : _____ Time: 30 mins.

F. M. : 10

Registration No.: _____

Date : _____

SECTION "A"
[20Q. × 0.5 = 10 marks]

Mark [×] in the appropriate box.

1. Which of the following is the extensive property of a thermodynamic system?
 Pressure Volume Temperature Density

2. The value of 1 mm of Hg is equal to
 1.333 N/m² 13.33 N/m² 133.3 N/m² 1333 N/m²

3. Kelvin Planck's Law deals with
 conservation of work conservation of heat
 conversion of heat into work conversion of work into heat

4. The state of substance whose evaporation from its liquid state is complete, is known as
 vapor perfect gas air steam

5. All perfect gases change in volume by 1/273rd of its original volume at 0°C for every 1°C change in temperature, when the pressure remains constant. This statement is called
 Boyle's law Charles' law
 Gay Lussac's law Joule's law

6. Entropy of wet steam of 1 kg is given by
 $s_f + \frac{xh_{fg}}{T_s}$ $s_g + \frac{xh_{fg}}{T_s}$ $s_f + \frac{h_{fg}}{T_s}$ $s_f + C_{ps} \log_e \frac{T_{sup}}{T_s}$

7. The absolute zero pressure will be
 when molecular momentum of the system becomes zero
 at sea level
 at the temperature of -273 K
 at the center of the earth

8. A gas constant R is equal to
 sum of two specific heats difference of two specific heats
 product of two specific heats ratio of two specific heats

9. When a gas is to be stored, the type of compression that would be ideal is
 isothermal polytropic isochoric adiabatic

10. The expansion ratio (r) is the where v₁ is volume at the beginning of expansion and v₂ is volume at the end of expansion.
 $\frac{v_1}{v_2}$ $\frac{v_2}{v_1}$ $\frac{v_1+v_2}{v_1}$ $\frac{v_1+v_2}{v_2}$

11. The efficiency of Carnot cycle may be increased by
- increasing the highest temperature decreasing the highest temperature
 increasing the lowest temperature keeping the lowest temperature constant
12. Stirling and Ericsson cycles are
- reversible partially reversible
 irreversible quasi-static
13. A reversible heat engine operates between 1600K and T_2 K, and another reversible heat engine operates between T_2 K and 400K. If both engines have same heat input and output, temperature T_2 is equal to
- 800 K 1000 K 1200 K 1400 K
14. The efficiency of diesel cycle theoretically approaches to Otto cycle efficiency when
- cut-off ratio is increased cut-off ratio is decreased
 cut-off is zero cut-off is constant
15. The efficiency of gas turbine is given by the ratio of
- net work output and work done by the turbine
 net work output and heat supplied
 actual and isentropic temperature drop
 isentropic and actual increase in temperature
16. The amount of heat generated per kg of fuel is known as
- calorific value lower calorific value
 heat energy higher calorific value
17. In a cryogenic experiment, it is needed to keep a container at -125°C although it gains 100 W due to heat transfer. What is the smallest motor one would need for heat pump absorbing heat from the container and rejecting heat to the room at 20°C ?
- 95.84 kW 97.84 kW 99.84 kW 101.84 kW
18. The Bernoulli equation is restricted to fluids but the SFEE is valid for fluids as well.
- viscous compressible, frictionless incompressible
 frictionless incompressible, viscous compressible
 viscous incompressible, frictionless compressible
 none of the above
19. Hot air at 1500 K expands in a polytropic process to a volume 6 times as large with $n = 1.5$. Find the specific boundary work.
- 509.5 J/kg 5095 J/kg 509.5 kJ/kg 5095 kJ/kg
20. A solar energy-based heat engine which receives 80 kJ of heat at 100°C and rejects 70 kJ heat to the ambient at 30°C is to be designed. The thermal efficiency of the heat engine is
- 70 % 18.8 % 12.5 % 8.43 %

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F.M. : 40

SECTION "B"

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

1.

a. Tabulate any three major differences between classical and statistical approaches in thermodynamics. [3]

b. List any 4 points each of difference and similarities between heat and work. [2]

c. A system of volume V contains a mass m of gas at pressure p and temperature T . The macroscopic properties of the system obey the following relationship:

$$\left(p + \frac{a}{v^2}\right)(V - b) = mRT; \text{ where } a, b, \text{ and } R \text{ are constants.}$$

Obtain an expression for the displacement work done by the system during a constant-temperature expansion from volume V_1 to volume V_2 . Calculate the work done by a system which contains 10 kg of this gas expanding from 1 m^3 to 10 m^3 at a temperature of 293 K. Use the values $a=15.7 \times 10 \text{ Nm}^4$, $b=1.07 \times 10^{-2} \text{ m}^2$ and $R = 0.278 \text{ kJ/kgK}$. [3]

2.

a. Describe in brief the criteria of pure substance. Sketch a T-v diagram of pure substance indicating the names of all major regions. [3]

b. Steam at 3 bar and 0.9 dryness expands in a cylinder till the volume is four times that at the commencement. The law of expansion is $pv^{1.1} = c$. Determine the quality of steam after expansion. [2]

c. Steam at 7 bar and dryness fraction 0.95 expands in a cylinder behind a piston isothermally and reversibly to a pressure of 1.5 bar. The heat supplied during the process is found to be 420 kJ/kg. Calculate the change in internal energy, the change in enthalpy and the work done. [3]

3.

a. Discuss the quantitative / parametric changes in Steady Flow Energy Equation when a horizontally placed nozzle has vertical cavity / hole. [2]

b. Steam enters a nozzle with a velocity of 60 m/s at 800 kPa, 300°C and leaves the nozzle at 160 kPa and 0.96 dryness. The cross-sectional area at the exit is 12 cm^2 and considering the flow as adiabatic, determine the steam velocity at the exit and flow rate. [4]

c. Draw a schematic / block / T-v / T-s / T-h / P-v diagram for a thermodynamic system/cycle with a refrigerator working from the output of a steam turbine. Provide suitable notation for each individual process. [2]

4.

a. Provide the statement(s) of second law of thermodynamics. Explain with suitable illustration why the violation of one statement violates the other. [4]

b. A fluid undergoes reversible adiabatic compression from 4 bar, 0.3m^3 to 0.08m^3 according to the law $Pv^{1.25}=\text{constant}$. Determine [4]

- i. Change in Enthalpy
- ii. Change in Internal Energy
- iii. Change in Entropy
- iv. Heat and work Transfer

5.

a. A steam power plant operates on a simple Rankine cycle between the pressure limits of 2 MPa and 20 kPa. The temperature of the steam at the turbine inlet is 400°C , and the mass flow rate of steam is 50 kg/s. Determine [4]

- i. The thermal efficiency of the cycle
- ii. The net power output of the plant

b. The compression and expansion ratio (v_5/v_4) of an oil engine working on the dual cycle (as given in figure below) are 9 and 5 respectively. The initial pressure and temperature of the air are 1 bar and 30°C . The heat liberated at the constant pressure process is twice that at constant volume process. The expansion and compression processes follow the law $PV^{1.25}=\text{constant}$. Determine the pressures and temperatures at all the salient points. [4]

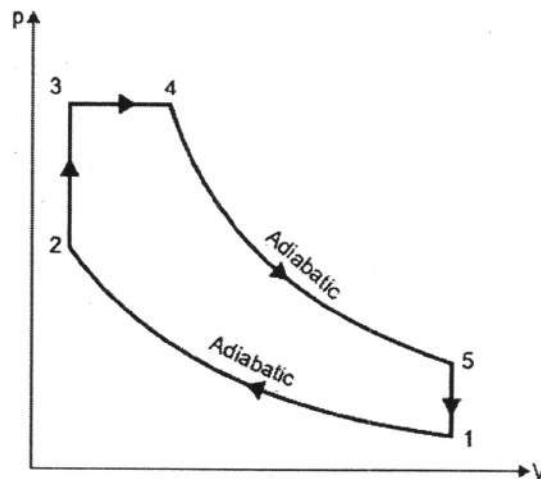


Figure 1: P-v Diagram of Dual Cycle