KATHMANDU UNIVERSITY
End Semester Examination [C]
January, 2019

Marks scored:

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

Course : MEEG 207
Semester: II

Exam Roll No.:

Time: 30 mins.

F.M : 20

Registration No.:

Date JAN 0 1 2019

SECTION "A"
[20 Q.×1=20 marks]

Tick the most appropriate answer.

1. In a given process on an ideal gas dW = 0 and dQ < 0. Then for the gas .....
   [ ] the volume will increase [ ] the pressure will remain constant
   [ ] the temperature will decrease [ ] the temperature will increase

2. For a process from state 1 to state 2, heat transfer in a reversible process is given by .....
   [ ] $\frac{T}{(S_1-S_2)}$ [ ] $\frac{T}{(S_2-S_1)}$ [ ] $T \times (S_1 - S_2)$ [ ] $T \times (S_2 - S_1)$

3. A piston cylinder with a cross sectional area of 0.01 m^2 is resting on the stops. With an outside pressure of 100 kPa, what should be the water pressure to lift the piston?
   [ ] 178 kPa [ ] 188 kPa [ ] 198 kPa [ ] 208 kPa

4. A 5 m^3 container is filled with 840 kg of granite (density us 2400 kg/m^3) and the rest of the volume is air (density us 1.15 kg/m^3). Find the mass of air present in the container.
   [ ] 9.4 kg [ ] 8.4 kg [ ] 6.4 kg [ ] 5.4 kg

5. All gases and vapors approach ideal gas behaviors at .....
   [ ] high pressure and high density [ ] low pressure and low density
   [ ] high pressure and low density [ ] low pressure and high density

6. Flow work is analogous to..... work.
   [ ] shaft [ ] electrical [ ] stirring [ ] displacement work

7. A piston of mass 2 kg is lowered by 0.5 m. Find the work involved in the process.
   [ ] 7.8 J [ ] 9.8 J [ ] 11.8 J [ ] 13.8 J

8. Heat transferred at constant pressure ..... the enthalpy of a system.
   [ ] increases [ ] decreases
   [ ] first decreases than increases [ ] first increases than decreases

9. The function of a typical diffuser is to .....the pressure of the fluid ..... its kinetic energy.
   [ ] increase, at the expense of [ ] decrease, and increase
   [ ] increase, and also increase [ ] decrease, and also decrease

10. The enthalpy and internal energy are the function of temperature for .....
    [ ] all gases [ ] steam [ ] water [ ] ideal gas

11. 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
[ ] non viscous compressible, frictional incompressible

12. A piston cylinder contains CO_2 at 300 kPa, with volume of 0.2 m^3 and at 100°C. Mass is added at such that the gas compresses with $PV^{1.2}$ = constant to a final temperature of 200° C. Determine the work done during the process.
[ ] -80.4 kJ [ ] -60.4 kJ [ ] 80.4 kJ [ ] 60.4 kJ

13. 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

14. If thermal efficiency of a Carnot heat engine is 40%, then coefficient of performance of a refrigerator working within the same temperature limits would be .....
[ ] 1.5 [ ] 2.5 [ ] 3.5 [ ] 4.5

15. Entropy is a ..... function and ..... property.
[ ] path, intensive [ ] path, extensive
[ ] point, intensive [ ] point, extensive

16. 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.
[ ] 209.5 kJ/kg [ ] 309.5 kJ/kg
[ ] 409.5 kJ/kg [ ] 509.5 kJ/kg

17. In a 2-stroke engine, the four functions performed in SI engine are done in which two strokes?
[ ] expansion, compression [ ] intake, exhaust
[ ] compression, power [ ] compression, expansion

18. The processes in CI engine is completed in ..... strokes of piston and ..... revolutions of crankshaft.
[ ] four, four [ ] two, two [ ] two, four [ ] four, two

19. The efficiency of Brayton cycle depends on .....
[ ] Compression ratio
[ ] Pressure ratio
[ ] either of compression or pressure ratio
[ ] both compression and pressure ratio

20. The evaporation process is a ..... process.
[ ] constant pressure reversible [ ] constant volume reversible
[ ] adiabatic throttling [ ] reversible adiabatic

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Semester: II
F.M. : 55

SECTION "B"
[5Q × 11 = 55 marks]

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

Q.N.1

a. A gas compressed from $V_1 = 0.09\ m^3$, $P_1 = 1$ bar to $V_2 = 0.03\ m^3$, $P_2 = 3$ bar. Pressure and volume are related linearly during the process. For the gas, find the work in kJ. [2]

b. A cylinder fitted with a movable piston contains 9 m^3 of air at 1 bar and 400 K. The air expands according to the law $V=Ap^4 + Bp^3$ to a final pressure of 2 bar when the volume is 112 m^3. Calculate the work done during the expansion. [5]

c. Derive an expression for polytropic displacement work. [4]

Q.N.2

a. Derive the quantitative relation between two type of specific heats. [3]

b. Sketch a temperature-volume (TV) diagram of any pure substance with appropriate indication for phase changes, process and critical point(s). [4]

c. A vessel contains one kg of steam which contains 1/3 liquid and 2/3 vapor by volume. The temperature of the steam is 151.86° C. Find the quality, specific volume and specific enthalpy of the mixture. [4]

Q.N.3

a. The following table gives data, in kJ, for a system undergoing a thermodynamic cycle consisting of four processes in series. For the cycle, kinetic and potential energy effects can be neglected. Determine: [3]

i. The missing table entries, each in kJ.
ii. Whether the cycle is a power cycle or a refrigerator cycle?

Process	Change in Internal Energy	Heat	Work
1-2	600		-600
2-3			-1300
3-4	-700	0	
4-1		500	700

b. Steam enters the nozzle at 1 MPa, 300° C, with a velocity of 30 m/s., the pressure of the steam at the nozzle exit is 0.3 MPa. Determine the exit velocity of the steam from the nozzle, assuming a reversible, adiabatic, steady flow process. [5]

c. List the assumptions for steady flow energy equations. Discuss briefly the significance of characteristics equations of state. [2+1]

Q.N.4

a. Derive first and second TdS equation from the statement of first law of thermodynamics. Give the expression for entropy change in: [5]
   i. Isolated system,
   ii. Incompressible substance-based system and
   iii. Ideal gas system with only pressure and temperature relations.

b. 2 kg of water at 90° C is mixed with 3 kg of water at 10° C in an isolated system. Calculate the change of enthalpy due to the mixing process. (C_p = 4.18 kJ/kg. K) [2]

c. Using suitable illustration and numerical representations, proof the validity of Inequality of Clausius. [4]

Q.N.5

a. An ideal Otto cycle has a compression ratio of 8. At the beginning of the compression process air is at 100 kPa, 17° C and 800 kJ/kg of heat is transferred to air, during constant volume heat addition process. Taking cold air standard assumptions, determine: (Take C_v = 0.718 kJ/kg) [3+1+1+1+1+2]

   i. Temperature and pressure at the end of each process.
   ii. Maximum temperature and pressure in the cycle.
   iii. Net-work output
   iv. Thermal efficiency
   v. Mean effective pressure
   vi. Determine the power output of the cycle in kW for an engine speed of 4000 rpm. Assume the cycle is operated on four-stroke engine with total displacement of 1.6 lts

b. Discuss any two ways of increasing Rankine Cycle thermal efficiency, highlighting the difficulty associated with these methods. (diagrams are optional) [2]