

### Third Semester

*(For the candidates admitted during the academic year 2022-2023 onwards)*

i. **Part - A** should be answered in OMR sheet within first 40 minutes and OMR sheet should be handed over to hall invigilator at the end of 40<sup>th</sup> minute.

Time: 3 Hours

Marks BL CO

1.	The macroscopic approach to the study of thermodynamics that does not require a knowledge of the behavior of individual particles is called _____	1	2	1
	(A) Statistical thermodynamics (B) Classical thermodynamics			
	(C) Analytical thermodynamics (D) Experimental thermodynamics			
2.	The mass or region outside the system is called the _____	1	2	1
	(A) Boundary (B) Atmosphere			
	(C) Surroundings (D) Stratosphere			
3.	An open system is also called as _____	1	2	1
	(A) Control volume (B) Control mass			
	(C) Control surface (D) Control area			
4.	_____ are those that are independent of the mass of a system	1	2	1
	(A) Extensive properties (B) Intrusive properties			
	(C) Extrusive properties (D) Intensive properties			
5.	The complete conversion of low grade energy into high grade energy in a cycle is _____	1	2	2
	(A) Possible (B) Impossible			
	(C) Both (D) None of the above			
6.	A hypothetical body with a relatively large thermal energy capacity (mass specific heat) that can supply or absorb finite amounts of heat without undergoing any change in temperature. Such a body is called a _____	1	2	2
	(A) Storage reservoir (B) Mass reservoir			
	(C) Thermal energy reservoir (D) Process			
7.	The _____ is defined as the energy required to raise the temperature of a unit mass of a substance by one degree	1	2	2
	(A) Specific heat (B) Latent heat			
	(C) Molecular heat (D) Pressure energy reservoir			
8.	In boiler, the steam is condensed to water in the condenser in amount of heat is _____	1	2	2
	(A) Rejected (B) Absorbed			
	(C) Neither rejected nor absorbed (D) None of the above			
9.	The cyclic integral of $\delta Q/T$ is always less than or equal to _____	1	2	3
	(A) 0 (B) 1			
	(C) 2 (D) 3			
10.	The Clausius inequality is valid for _____	1	2	3
	(A) Reversible cycle (B) Irreversible cycle			
	(C) Refrigeration cycle (D) All of the above			

11. Entropy is an _____ property of a system	1	2	3
(A) Intensive			
(B) Extensive			
(C) Intrusive			
(D) Both intensive and extensive			
12. The entropy generated during a process is called _____	1	2	3
(A) Total entropy			
(B) Differential entropy			
(C) Entropy formation			
(D) Entropy generation			
13. The premature ignition of the fuel is called	1	2	4
(A) Detonation			
(B) Autoignition			
(C) Knocking			
(D) Pyrotechnic ignition			
14. Which process is not involved in the Ideal Otto cycle	1	2	4
(A) Isentropic compression			
(B) Constant-volume heat addition			
(C) Isentropic expansion			
(D) Constant-pressure heat rejection			
15. The Carnot cycle is composed of _____ totally reversible processes:	1	2	4
(A) 1			
(B) 2			
(C) 3			
(D) 4			
16. Reversible isothermal heat transfer is very difficult to achieve in reality because it would require very large	1	2	4
(A) Heat pumps			
(B) Heat exchangers			
(C) Heat engines			
(D) All of the above			
17. A radiant heating lamp has a surface temperature of 1000 K with $\epsilon = 0.8$ . How large a surface area is needed to provide 250 W of radiation heat transfer?	1	3	5
(A) 0.0035 m <sup>2</sup>			
(B) 0.0045 m <sup>2</sup>			
(C) 0.0055 m <sup>2</sup>			
(D) 0.0065 m <sup>2</sup>			
18. The rate at which energy is radiated by a black body at temperature T (K) is given by a	1	2	5
(A) Newtons law			
(B) Kirchoff's law			
(C) Stefan-Boltzmann law			
(D) Avagadro law			
19. The property of the material through which heat is being conducted and is known as	1	2	5
(A) Thermal contraction			
(B) Thermal conductivity			
(C) Thermal expansion			
(D) Thermal diffusion			
20. Fourier's law of heat conduction states that the rate of heat flux is linearly proportional to the	1	2	5
(A) Temperature gradient			
(B) Pressure gradient			
(C) Velocity gradient			
(D) Volume gradient			

**PART - B (5 × 8 = 40 Marks)**

Answer all Questions

Marks BL CO

21.	(a) Write short notes on (i) Point and Path functions (ii) Intensive and extensive properties (iii) Microscopic and macroscopic view of thermodynamics	8	2	1
	(OR)			
	(b) Derive the steady flow energy equation and simplify it to be applicable for a gas turbine and a compressor.			
22.	(a) State and prove Carnot theorem.	8	3	2
	(OR)			
	(b) A heat pump is used to meet the heating requirements of a house and maintain it at 20°C. On a day when the outdoor air temperature drops to 2°C, the house is estimated to lose heat at a rate of 80,000 kJ/h. If the heat pump under these conditions has a COP of 2.5, determine (a) the power consumed by the heat pump and (b) the rate at which heat is absorbed from the cold outdoor air.			

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|-----|---|---|---|---|
| 23. | (a) Derive the Clapeyron equation and point out its utility.<br>(OR)<br>(b) Derive Maxwell's equations and write down the first and second Tds equations.   | 8 | 3 | 3 |
| 24. | (a) An ideal Diesel cycle with air as the working fluid has a compression ratio of 18 and a cutoff ratio of 2. At the beginning of the compression process, the working fluid is at 14.7 psia, 80°F, and 117 in <sup>3</sup> . Utilizing the cold-air standard assumptions, determine (a) the temperature and pressure of air at the end of each process, (b) the net work output and the thermal efficiency, and (c) the mean effective pressure.<br>(OR)<br>(b) Explain the ideal Otto cycle with the help of P-V and T-S diagrams.   | 8 | 3 | 4 |
| 25. | (a) Mention and define the three modes of Heat transfer. Explain in detail the conduction through a wall.<br>(OR)<br>(b) A cold storage room has walls made of 0.23 m of brick on the outside, 0.08 m of plastic foam, and finally 1.5 cm of wood on the inside. The outside and inside air temperatures are 22°C and - 2°C respectively. If the inside and outside heat transfer coefficients are respectively 29 and 12 W/m <sup>2</sup> K, and the thermal conductivities of brick, foam, and wood are 0.98, 0.02, and 0.17 W/mK respectively, determine (a) the rate of heat removed by refrigeration if the total wall area is 90 m <sup>2</sup> , and (b) the temperature of the inside surface of the brick. | 8 | 3 | 5 |

**PART - C (1 × 15 = 15 Marks)**

Answer any 1 Questions

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|-----|---|----|---|---|
| 26. | In a steady flow apparatus, 135 kJ of work is done by each kg of fluid. The specific volume of the fluid, pressure and velocity at the inlet are 0.37 m <sup>3</sup> /kg, 600kPa and 16 m/s. The inlet is 32 m above the floor, and the discharge pipe is at floor level. The discharge conditions are 0.62 m <sup>3</sup> /kg, 100 kPa, and 270 m/s. The total heat loss between the inlet and discharge is 9 kJ/kg of fluid. In flowing through this apparatus, does the specific internal energy increase or decrease, or by how much? | 15 | 3 | 1 |
| 27. | Derive (i) the steady flow energy equation (ii) A cyclic heat engine operates between a source temperature of 800°C and a sink temperature of 30°C. What is the least rate of heat rejection per kW net output of the engine?   | 15 | 3 | 2 |

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