CBCS SCHEME

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18AE/AS32

# Third Semester B.E. Degree Examination, Dec.2024/Jan.2025
## Aero Thermodynamics

Time: 3 hrs. Max. Marks: 100

**Note : 1.** ***Answer any FIVE full questions, choosing ONE full question from each module.***
**2.** ***Use of Thermodynamics Data Handbook and Steam table is permitted.***



### Module-1

1 a. Differentiate between with schematics :
i) Microscopic and Macroscopic view points.
ii) Intensive and Extensive properties.
iii) Path and point functions. **(06 Marks)**

b. With the help of relevant sketches, explain Quasistatic process. **(06 Marks)**

c. State Zeroth law of thermodynamics. The temperature 'T' on the thermometric scale is defined as T = a ℓn K + b where 'a' and 'b' are constants. The values of K are found to be 1.83 and 6.78 at o°C and 100°C respectively. Calculate the temperature for a value of K = 2.42. **(08 Marks)**

**OR**

2 a. A system undergoes a process in which the pressure and volume are related by a equation of the form $PV^n$ = Constant. Derive an expression for displacement work during this process. **(08 Marks)**

b. Distinguish between Heat and Work. **(06 Marks)**

c. A mass of gas is compressed in a quasistatic process from 80 Kpa , $0.1m^3$ to 0.4Mpa , $0.03m^3$. Assuming that the pressure and volume are related by $PV^n$ = constant, find the work interaction during the process. Is it a work producing system or work absorbing system? **(06 Marks)**

### Module-2

3 a. Explain Joules experiment with a neat sketch. **(08 Marks)**

b. Prove that internal energy is a property of the system. **(06 Marks)**

c. To a closed system 150 kJ of work is supplied. If the initial volume is $0.6m^3$ and pressure of the system changes as P = 8 – 4V , where P is in bar and V is in $m^3$, determine the final volume of the system. **(06 Marks)**

**OR**

4 a. Derive from the fundamentals , steady flow energy equation for an open system. **(10 Marks)**

b. Air enters an adiabatic nozzle steadily at 300 Kpa , 200°C and 30m/s and leaves at 100Kpa and 180m/s. The inlet area of the nozzle is $80cm^2$. Determine :
i) The mass flow rate through the nozzle.
ii) The exit temperature of the air.
iii) The exit area of the nozzle. **(10 Marks)**

## Module-3

5 a. State Kelvin Planck and Clausius statements of second law of thermodynamics and show that they are equivalent. **(10 Marks)**

b. A reversible heat engine operates between two reservoirs at temperature of 600°C and 40°C. The engine drives a reversible refrigerator, which operated between 40°C and -20°C. The heat transfer to the engine is 2000kJ and network output from combined engine and refrigerator system is 360kJ. Calculate heat transfer to the refrigerator and net heat transfer to the reservoir at 40°C. **(10 Marks)**

**OR**

6 a. Define Clausius inequality and entropy of a system. Show that for an in reversible process , $ds \geq \frac{\delta Q}{T}$ . **(08 Marks)**

b. Prove that entropy is a property of a system. **(06 Marks)**

c. Deduce an expression for principle of increase of entropy , $ds \geq \frac{\delta Q}{T}$. **(06 Marks)**

## Module-4

7 a. Define the following : i) Critical point ii) Triple point iii) Saturation pressure iv) Dryness fraction v) Pure substance vi) Latent Heat. **(06 Marks)**

b. Sketch and explain P-T diagram of water. **(06 Marks)**

c. One kg of ice at -5°C is exposed to atmosphere which is at 20°C. The ice melts and comes into thermal equilibrium with the atmosphere. Determine the entropy increase of the universe. Take Cp of ice is 2.093 kJ/kg and latent heat of fusion of ice = 334 kJ/kg. **(08 Marks)**

**OR**

8 a. Derive and explain Maxwell equation. **(08 Marks)**

b. Explain with sketches : i) Equation of state
ii) Co-efficient of expansion and compressibility.
iii) Enthalpy of vaporization. **(06 Marks)**

c. In a turbine, 75 kg per second of air expands polytropically from 4.25 bar and 1360 K to 1.01 bar. The exponent n = 1.45, calculate the work and heat interactions. **(06 Marks)**

## Module-5

9 a. Derive the expression for the air standard efficiency of an otto cycle. **(10 Marks)**

b. In an air standard diesel cycle, the compression ratio is 16. At the beginning of isentropic expression , the temperature is 15°C and pressure is 0.1Mpa. Heat is added until the temperature at the end of the constant pressure process is 1480°C. Calculate
i) Cut – off ratio ii) Heat supplied per kg of air iii) Cycle efficiency. **(10 Marks)**

**OR**

10 a. Sketch the schematic diagram and corresponding T – S diagram, of a reheat vapour cycle and evaluate an expression for reheat cycle efficiency. **(10 Marks)**

b. Steam enters the turbine of a steam power plant operating on Rankine cycle, at 10 bar , 300°C. the condenser pressure is 0.1bar. Steam leaving the turbine is 90% dry. Calculate the adiabatic efficiency of the turbine and also the cycle efficiency neglecting pump work. **(10 Marks)**

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