VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY (VSSUT), ODISHA

Odd Mid Semester Examination for Academic Session 2024-25

COURSE NAME: **B. Tech** | SEMESTER: **3rd**

BRANCH NAME: **Mechanical Engineering**

SUBJECT NAME: **Basic Thermodynamics**

FULL MARKS: **30** | TIME: **90 Minutes**

Use of steam table is allowed

Answer **All** Questions.

The figures in the right-hand margin indicate Marks. *Symbols carry usual meaning.*

Q1.		Answer all Questions.	**[2 × 3]**
	a)	Separate the list Pressure, Force, Volume, Specific Volume, Density, Temperature, Acceleration, Mass, Length, Time, and Velocity, Work, and Heat.	- CO1
	b)	Three kilograms of water in a container have a pressure of 100 kPa and temperature of 150°C. What is the volume of this container?	- CO2
	c)	An ideal gas in a piston/cylinder is heated with 2 kJ during an isothermal process. How much work is involved?	- CO3
Q2.			**[4+4]**
	a)	A piston–cylinder device contains 0.6 kg of steam at 200°C and 0.5 MPa. Steam is cooled at constant pressure until one-half of the mass condenses. (a) Show the process on a T-v diagram. (b) Find the final temperature. (c) Determine the volume change.	- CO1
	b)	A 13-m^3 tank contains nitrogen at 17°C and 600 kPa. Some nitrogen is allowed to escape until the pressure in the tank drops to 400 kPa. If the temperature at this point is 15°C, determine the amount of nitrogen that has escaped.	
		OR	
	a)	A rigid container contains steam at a pressure of 10 bar with an unknown quality. On heating the steam passes through the critical point at its final state. Determine the quality of steam at its initial state.	- CO1
	b)	A rigid tank whose volume is unknown is divided into two parts by a partition. One side of the tank contains an ideal gas at 927°C. The other side is evacuated and has a volume twice the size of the part containing the gas. The partition is now removed and the gas expands to fill the entire tank. Heat is now applied to the gas until the pressure equals the initial pressure. Determine the final temperature of the gas.	

① $PV^n = C$, ② $PV = mRT$, $R = C_p - C_v$, $\frac{C_p}{C_v} = \gamma$

Enthalpy $H = U + PV$

$Q = W + \Delta KE + \Delta PE + \Delta h$

Discharge $= A \times V$

Bernoulli eq^n $= \frac{dP}{\rho} + \Delta KE + \Delta KE = 0$

mass flow rate $= \rho A V$

Q3			[4+4]
	a)	An insulated rigid tank is divided into two equal parts by a partition. Initially, one part contains 4 kg of air at 800 kPa and 50°C, and the other part is evacuated. The partition is now removed, and the gas expands into the entire tank. Determine the final temperature and pressure in the tank.	- CO2
	b)	A piston–cylinder device contains 2.2 kg of nitrogen initially at 100 kPa and 25°C. The air is now compressed slowly in a polytropic process during which until the volume is reduced by one-half. Determine the work done and the heat transfer for this process.	
		OR	[8]
		A certain mass of air initially at 150 kPa, 0.13 m^3 is compressed in a reversible polytropic process to 700 kPa. During this process heat transfer to air is 20 kJ and internal energy of air increases by 50 kJ. Find the final volume of air.	- CO2
Q4			[8]
		Steam at 4 MPa and 400°C enters a nozzle steadily with a velocity of 60 m/s, and it leaves at 2 MPa and 300°C. The inlet area of the nozzle is 50 cm^2, and heat is being lost at a rate of 75 kJ/s. Determine (a) the mass flow rate of the steam, (b) the exit velocity of the steam, and (c) the exit area of the nozzle.	- CO3
		OR	[4+4]
	a)	There are two methods available for maintaining desired room temperature during winter season. The first one: Heat pump and the second one is by placing a resistance heater inside the room. Which method is a more efficient way of heating room air? Explain.	- CO3
	b)	An ideal (Carnot) heat engine has an efficiency of 40%. If the high temperature is raised 15%, what is the new efficiency keeping the same low temperature?	