Enrolment No/Seat No.: _____

R.N.G.PATEL INSTITUTE OF TECHNOLOGY-RNGPIT

(An Autonomous Institute U/s UGC Act 1956)

B.Tech. SEMESTER-III, SEMESTER END EXAMINATION – WINTER 2025

SUBJECT CODE: 1CH301 **DATE: 16-12-2025**

SUBJECT NAME: BASICS OF THERMODYNAMICS

TIME: 11:00 AM to 01:30 PM **TOTAL MARKS: 70**

Instructions

1. It is **compulsory** for students to write **Enrolment No. /Seat No.** on the question paper.
2. Write answers of **Section A** and **Section B** in **separate answer books**.
3. Attempt all questions from both **Section A** and **Section B**.
4. Each section carries **35 marks**, with a total of **70 marks** for the examination.
5. The figures to the right of each question indicate full marks, make suitable assumptions with justification.
6. BL - Cognitive Level (As per Revised Bloom's Taxonomy) (R-Remember, U-Understanding, A –Application, N –Analyze, E – Evaluate, C -Create), CO - Course Outcomes.

SECTION A

			Marks	BL	CO
Q.1	**(a)**	Explain the concept of thermodynamics system and its classification.	**03**	**U**	**1**
	(b)	Describe in detail: (i) internal energy, (ii) enthalpy, (iii) entropy, (iv) heat capacity	**04**	**U**	**1**
Q.2	**(a)**	State and explain the Zeroth Law of Thermodynamics.	**03**	**U**	**2**
	(b)	Write down the entropy changes of an ideal gas.	**04**	**R**	**2**
	(c)	Explain the significance of the Third Law of Thermodynamics.	**07**	**U**	**2**
		OR			
Q.2	**(a)**	State the First Law of Thermodynamics in detail.	**03**	**U**	**2**
	(b)	Write application of First Law of Thermodynamics to steady state flow process.	**04**	**R**	**2**
	(c)	Describe the Second Law of Thermodynamics.	**07**	**U**	**2**
Q.3	**(a)**	Explain the difference between ideal and non-ideal gas behavior with suitable examples.	**03**	**U**	**3**
	(b)	State the assumptions of an ideal gas and write the ideal gas equation	**04**	**U**	**3**
	(c)	Explain the P–V–T behavior of pure substances with the help of a phase diagram.	**07**	**U**	**3**

OR

Q.3	**(a)**	Explain the Redlich–Kwong Equation of State.	**03**	**U**	**3**
	(b)	Write the Virial equation of state and discuss the significance of the second Virial coefficient.	**04**	**U**	**3**
	(c)	Explain the van der waals Equation of State and express the constants a and b in terms of Pc, Tc, Vc.	**07**	**U**	**3**

SECTION B

			Marks	BL	CO
Q.4	**(a)**	Define the following properties and give one example each: (i) Residual property (ii) Intensive property (iii) Extensive property.	**03**	**R**	**4**
	(b)	Explain Maxwell's equations. How are they useful in determining thermodynamic properties of fluids?	**04**	**U**	**4**
Q.5	**(a)**	Distinguish between **sensible heat** and **latent heat** with suitable examples.	**03**	**U**	**5**
	(b)	Calculate the heat required to raise the temperature of **2 kmol** of an ideal gas from **300 K to 500 K**, given Cp = 30 kJ/kmol.K.	**04**	**A**	**5**
	(c)	A hydrocarbon combustion reaction is carried out in two different temperature conditions. Analyze how **temperature dependence of standard heat of formation** affects the overall heat effect of reaction. Support your answer with suitable thermodynamic concepts.	**07**	**N**	**5**
		OR			
Q.5	**(a)**	Explain why **temperature-dependent heat capacity** must be considered for accurate heat effect calculations.	**03**	**U**	**5**
	(b)	A liquid with constant Cp=2.8 kJ/kg.K is heated from **20°C to 120°C**. Determine the **sensible heat required** for **5 kg** of liquid.	**04**	**A**	**5**
	(c)	Analyze the methods used to estimate **latent heat of vaporization** and compare their applicability for different industrial fluids. Provide examples.	**07**	**N**	**5**
Q.6	**(a)**	A refrigerator extracts **350 kJ/min** of heat at an evaporator temperature of **−10°C**. If its COP is **3.5**, calculate the **power input**.	**03**	**A**	**6**
	(b)	Compare **heat pumps** and **heat engines** based on efficiency and operating principle. Evaluate which system is more suitable for industrial heating applications and justify your reasoning.	**04**	**E**	**6**
	(c)	Evaluate the performance of a **vapour compression refrigeration system** over a **vapour absorption refrigeration system** for chemical processing industries considering COP, environmental effects, and operating cost.	**07**	**E**	**6**
		OR			
Q.6	**(a)**	Carnot engine operates between **600 K** and **300 K**. Calculate its thermal efficiency.	**03**	**A**	**6**
	(b)	Evaluate how the **choice of refrigerant** affects the COP and environmental sustainability of refrigeration systems. Provide suitable arguments.	**04**	**E**	**6**

(c)	Evaluate different **liquefaction processes** used in gas industries and justify which is best for large-scale LNG production, considering thermodynamic performance.	**07**	**E**	**6**

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