THERMODYNAMICS (ME305PC)

COURSE PLANER

VI. COURSE OVERVIEW:

This course provides an introduction to the most powerful engineering principles you will ever learn - Thermodynamics: the science of transferring energy from one place or form to another place or form. We will introduce the tools you need to analyze energy systems from solar panels, to engines, to insulated coffee mugs. More specifically, we will cover the topics of mass and energy conservation principles; first law analysis of control mass and control volume systems; properties and behavior of pure substances; and applications to thermodynamic systems operating at steady state conditions.

VII. PREREQUISITE(S):

The knowledge of following subjects is essential to understand the subject:

1. Physics
2. Knowledge of Differential equations

VIII. COURSE OBJECTIVES:

The objectives of the course are to enable the student

- To understand the basic definitions and terminology from the thermodynamics point of view.
- To be able to analyse the significance of thermodynamic air standard and vapor cycles.
- To be able to understand concept of entropy and its significance in real situations.
- To be able to understand the properties of pure substances such as ideal gas and steam and mixture of different gases.
- To be able to understand the properties of moist air "psychometric".

IX. COURSE OUTCOMES

Sl. NO	Description	Bloom's Taxonomy level
CO1	Able to understand the basic concepts which are useful in calculation of energy interactions	Knowledge, Understand(Level1 Level2)
CO2	Able to understand principle of thermometry and different thermometers	Knowledge, Understand(Level1 Level2) and applica
CO3	Able to apply simple energy balance equations for closed and open system by understanding I st law of thermodynamics	Knowledge, Understand(Level 1, Level2) and application L3

CO4	Able to formulate true efficiency of a cyclic heat engines and heat pumps.	Knowledge, Understand(Level 1, Level2) and application L3
CO5	Understand the properties of pure substance with phase change which are useful in power plants.	Knowledge, Understand(Level 1, Level2) and application L3
CO6	Able to apply the simple principles of psychometric to evaluate the air conditioning principles.	Knowledge, Understand(Level 1, Level2) and application L3

X. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Level	Proficiency assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1	Assignments
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Assignments/ exams
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	3	Assignments/ exams
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Assignments
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	2	-
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	2	-
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for	2	-

	sustainable development.		
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	3	-
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	2	Projects
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	Seminars
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	3	Projects
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	1	Assignments' /Exams

VI. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Level	Proficiency assessed by
PSO1	The student will be able to apply the knowledge of Mathematics, Sciences and engineering fundamentals to formulate, analyze and provide solutions for the problems related to Mechanical engineering and communicate them effectively to the concerned.	2	Assignments
PSO2	Design mechanical systems in various fields such as machine elements, thermal, manufacturing, industrial and inter-disciplinary fields by using various engineering/technological tools to meet the mercurial needs of the industry and society at large.	2	Assignments
PSO3	The ability to grasp the latest development, methodologies of mechanical engineering and posses competent knowledge of design process, practical proficiencies, skills and knowledge of programme and developing ideas towards research.	3	-

VII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CO's	Program Outcomes (PO's)											
	PO1	PO2	PO3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO12
CO1	3	2	3	2	2	--	--	3	--	2	--	3
CO2	3	2	3	2	2	--	--	2	--	1	--	3

CO3	3	3	3	2	2	--	--	1	--	2	--	2
CO4	1	2	2	1	2	--	--	3	--	2	--	3
CO5	3	3	3	2	1	--	--	3	--	1	--	3
CO6	2	3	3	2	3	--	--	3	--	2	--	1
Average	**2.5**	**2.5**	**2.8**	**1.8**	2	--	--	**2.5**	**--**	**1.6**	**--**	**2.5**

Program Specific Outcomes (PSO's)

CO's	PSO1	PSO2	PSO3
CO1	2	1	1
CO2	2	1	1
CO3	3	1	1
CO4	2	1	1
CO5	2	1	1
CO6	2	1	1
Average	**2.16**	**1**	**1**

VIII. SYLLABUS:

Unit – I	Introduction: Basic Concepts: System, Control Volume, Surrounding, Boundaries, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Exact & Inexact Differentials, Cycle – Reversibility – Quasi – static Process, Irreversible Process, Causes of Irreversibility – Energy in State and in Transition, Types, Displacement & Other forms of Work, Heat, Point and Path functions, Zeroth Law of Thermodynamics Concept of Temperature – Principles of Thermometry – Reference Points Const. Volume gas Thermometer – Scales of Temperature, Ideal Gas Scale
Unit – II	PMM I - Joule's Experiments – First law of Thermodynamics – Corollaries – First law applied to a Process – applied to a flow system – Steady Flow Energy Equation. Limitations of the First Law – Thermal Reservoir, Heat Engine, Heat pump , Parameters of performance, Second Law of Thermodynamics, Kelvin-Planck and Clausius Statements and their Equivalence / Corollaries, PMM of Second kind, Carnot's principle, Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality, Entropy, Principle of Entropy Increase – Energy Equation, Availability and Irreversibility – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations – Elementary Treatment of the Third Law of Thermodynamics

Unit – III	Pure Substances, p-V-T- surfaces, T-S and h-s diagrams, Mollier Charts, Phase Transformations – Triple point at critical state properties during change of phase, Dryness Fraction – Clausius – Clapeyron Equation Property tables. Mollier charts – Various Thermodynamic processes and energy Transfer – Steam Calorimetry. Perfect Gas Laws – Equation of State, specific and Universal Gas constants various Non-flow processes, properties, end states, Heat and Work Transfer, changes in Internal Energy – Throttling and Free Expansion Processes – Flow processes
Unit - IV	Deviations from perfect Gas Model – Vader Waals Equation of State – Compressibility charts – variable specific Heats – Gas Tables Mixtures of perfect Gases – Mole Fraction, Mass friction Gravimetric and volumetric Analysis – Dalton's Law of partial pressure, Avogadro's Laws of additive volumes – Mole fraction, Volume fraction and partial pressure, Equivalent Gas const. And Molecular Internal Energy, Enthalpy, sp. Heats and Entropy of Mixture of perfect Gases and Vapour, Atmospheric air - Psychrometric Properties – Dry bulb Temperature, Wet Bulb Temperature, Dew point Temperature, Thermodynamic Wet Bulb Temperature, Specific Humidity, Relative Humidity, saturated Air, Vapour pressure, Degree of saturation – Adiabatic Saturation, Carrier's Equation – Psychrometric chart.
Unit - V	**Power Cycles**: Otto, Diesel, Dual Combustion cycles, Sterling Cycle, Atkinson Cycle, Ericsson Cycle, Lenoir Cycle – Description and representation on P–V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air standard basis – comparison of Cycles. **Refrigeration Cycles:** Brayton and Rankine cycles – Performance Evaluation – combined cycles, Bell-Coleman cycle, Vapour compression cycle-performance Evaluation.

SUGGESTED BOOKS/RESOURCES:

Text books:

1. Engineering Thermodynamics / PK Nag /TMH, 5th Edition
2. Thermodynamics – An Engineering Approach by Cengel & Boles , McGraw Hill 8th Edition

Reference Books:

1. Engineering Thermodynamics/DPMishra/Cengage Learning/Second impression 2012
2. Engineering Thermodynamics/E Rathakrishnan/PHI/Second Edition/2013
3. Thermodynamics – J.P.Holman / McGrawHill
4. Engineering Thermodynamics – Jones & Dugan
5. Engineering Thermodynamics/P.Chattopadhyay/Oxford Higher Education/Revised First Edition
6. Thermodynamics & Heat Engines – Yadav – Central Book Depot, Allahabad.

NPTEL WEB COURSE:

http://nptel.ac.in/courses/112105123/
http://nptel.ac.in/courses/112105123/1
http://nptel.ac.in/courses/112105123/2
http://nptel.ac.in/courses/112105123/3
http://nptel.ac.in/courses/112105123/4
http://nptel.ac.in/courses/112105123/5
http://nptel.ac.in/courses/112105123/6

NPTEL VIDEO COURSE

https://youtu.be/9GMBpZZtjXM
https://youtu.be/xQwi9fveGTQ
https://youtu.be/sUDfpFD0xX4
https://youtu.be/xTpmdeq25YI

GATE SYLLABUS:

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics : Kelvin –Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances : Thermodynamic properties of pure substances in solid, liquid and vapor phases, P- V – T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T – ds relations, Maxwell equations, Joule – Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Thermodynamic Cycles: Carnot vapor power cycle, ideal Rankine cycle, Rankine Reheat cycle, Air standard Otto cycle, Air standard Diesel cycle, Air – standard Brayton cycle, Vapor – compression refrigeration cycle.

Ideal Gas Mixtures: Dalton's and amagat's laws, calculations of properties, air – water vapor mixtures and simple thermodynamic processes involving them.

IX: COURSE PLAN

Lecture No.	Unit No.	Date	Topics to be covered	Content to be covered under each topic	Link for PPT	Link for PDF	Link for Small Projects/ Numericals(if any)	Course learning outcomes	Teaching Methodology	Reference
1	I		Preamble to the course	Introduction to Thermodynamics	https://tinyurl.com/cjwt78xu	https://tinyurl.com/47vsmdrm	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics	Understand	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
2			Basic Concepts	System, Control Volume, Surrounding, Boundaries, Universe, Types of Systems	https://tinyurl.com/cjwt78xu	https://tinyurl.com/47vsmdrm	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
3			Macroscopic and Microscopic viewpoints,	Macroscopic and Microscopic viewpoints, Concept of Continuum,	https://tinyurl.com/cjwt78xu	https://tinyurl.com/47vsmdrm	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics	Understand	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
4			Thermodynamic Equilibrium, State, Property, Process	Thermodynamic Equilibrium, State, Property, Process	https://tinyurl.com/cjwt78xu	https://tinyurl.com/47vsmdrm	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
5				STUDENT PPT						

6			Exact & Inexact Differentials,	Exact & Inexact Differentials,	https://tinyurl.com/cjwt78xu	https://tinyurl.com/47vsmdrm	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics	Study	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
7			Cycle – Reversibility – Quasi – static Process, Irreversible Process,	Cycle – Reversibility – Quasi – static Process, Irreversible Process,	https://tinyurl.com/cjwt78xu	https://tinyurl.com/47vsmdrm	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics	Application	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
8			Causes of Irreversibility – Energy in State and in Transition,	Causes of Irreversibility – Energy in State and in Transition,	https://tinyurl.com/cjwt78xu	https://tinyurl.com/47vsmdrm	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics	Understand	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
9			Work & Heat	Types, Displacement & Other forms of Work, Heat, Point and Path functions,	https://tinyurl.com/cjwt78xu	https://tinyurl.com/47vsmdrm	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics	Understand	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
10				STUDENT PPT						
11			Zeroth Law of Thermodyna	Zeroth Law of Thermodyn	https://tinyurl.com/cjwt78xu	https://tinyurl.com/47vsmdrm	https://www.skyfilabs.com/project-	Understand	PPT, CHALK N	

			mics	amics			ideas/latest-projects-based-on-Thermodynamics		BOARD, VIDEOS	
12			Concept of Temperature	Concept of Temperature – Principles of Thermometry – Reference Points – Const. Volume gas Thermometer – Scales of Temperature, Ideal Gas Scale	https://tinyurl.com/cjwt78xu	https://tinyurl.com/47vsmdrm	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics	Application	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
13			PMM I - Joule's Experiments	Concept of PMM I - Joule's Experiments	https://tinyurl.com/74kub9xy	https://tinyurl.com/4zmjjk2b	https://mechanical.mini-projects.in/c/thermodynamics-projects	Study	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
14			First law of Thermodynamics – Corollaries	Deffination of First law of Thermodynamics – Corollaries	https://tinyurl.com/74kub9xy	https://tinyurl.com/4zmjjk2b	https://mechanical.mini-projects.in/c/thermodynamics-projects	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
15	II			STUDENT PPT						
16			First law applied to a Process – applied to a flow system	How First law applied to a Process – applied to a flow system –	https://tinyurl.com/74kub9xy	https://tinyurl.com/4zmjjk2b	https://mechanical.mini-projects.in/c/thermodynamics-projects	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
17			Steady Flow Energy Equation	Defination and derivatio	https://tinyurl.com/74kub9xy	https://tinyurl.com/4zmjjk2b	https://mechanical.mini-projects.in/c	Study	PPT, CHALK N	Engineering Thermodynamics / PK Nag /TMH,

				n of Steady Flow Energy Equation			/thermodynamics-projects		BOARD, VIDEOS	5th Edition
18			Limitations of the First Law	Defination of Thermal Reservoir, Heat Engine, Heat pump , Parameters of performance, Statements and their Equivalence / Corollaries,	https://tinyurl.com/74kub9xy	https://tinyurl.com/4zmjjk2b	https://mechanical.mini-projects.in/c/thermodynamics-projects	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
19			Second Law of Thermodynamics,	Defination of Second Law of Thermodynamics, Kelvin-Planck and Clausius	https://tinyurl.com/74kub9xy	https://tinyurl.com/4zmjjk2b	https://mechanical.mini-projects.in/c/thermodynamics-projects	Understand	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
20				STUDENT PPT						
21			PMM of Second kind, Carnot's principle, Carnot cycle and its specialties,	Concept of PMM of Second kind, Carnot's principle, Carnot cycle and its specialties,	https://tinyurl.com/74kub9xy	https://tinyurl.com/4zmjjk2b	https://mechanical.mini-projects.in/c/thermodynamics-projects	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
22			Thermodynamic scale of Temperature, Clausius Inequality, Entropy,	Concept of Thermodynamic scale of Temperature, Clausius Inequality,	https://tinyurl.com/74kub9xy	https://tinyurl.com/4zmjjk2b	https://mechanical.mini-projects.in/c/thermodynamics-projects	Study	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition

			Principle of Entropy Increase	Entropy, Principle of Entropy Increase					
23			Energy Equation, Availability and Irreversibility – Thermodynamic Potentials	Derivation of Energy Equation, Availability and Irreversibility – Thermodynamic Potentials	https://tinyurl.com/74kub9xy	https://tinyurl.com/4zmjjk2b	https://mechanical.mini-projects.in/c/thermodynamics-projects	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
24			Gibbs and Helmholtz Functions, Maxwell Relations –	Defination and Derivation of Gibbs and Helmholtz Functions, Maxwell Relations –	https://tinyurl.com/74kub9xy	https://tinyurl.com/4zmjjk2b	https://mechanical.mini-projects.in/c/thermodynamics-projects	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
25				STUDENT PPT						
26			Elementary Treatment of the Third Law of Thermodynamics	Concept of Elementary Treatment of the Third Law of Thermodynamics	https://tinyurl.com/74kub9xy	https://tinyurl.com/4zmjjk2b	https://mechanical.mini-projects.in/c/thermodynamics-projects	Understand	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK
27			Pure Substances, p-V-T- surfaces, T-S and h-s diagrams,	Concept of Pure Substances, p-V-T- surfaces, T-S and h-s diagrams,	https://tinyurl.com/kf2fj3xe	https://tinyurl.com/e5ynujwz	https://projectabstracts.com/tag/thermodynamics	Application	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
28	III		Mollier Charts, Phase Transformations –	Mollier Charts, Phase Transformations –	https://tinyurl.com/kf2fj3xe	https://tinyurl.com/e5ynujwz	https://projectabstracts.com/tag/thermodynamics	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition

29			Triple point at critical state properties uring change of phase, DrynesFraction	Concept of Triple point at critical state properties during change of phase, Dryness Fraction –	https://tinyurl.com/kf2fj3xe	https://tinyurl.com/e5ynujwz	https://projectabstracts.com/tag/thermodynamics	Study	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
30				STUDENT PPT						
31			Clausius – Clapeyron Equation Property tables.	Defination of Clausius – Clapeyron Equation Property tables.	https://tinyurl.com/kf2fj3xe	https://tinyurl.com/e5ynujwz	https://projectabstracts.com/tag/thermodynamics			Engineering Thermodynamics / PK Nag /TMH, 5th Edition
32			Mollier charts – Various Thermodynamic processes and energy Transfer – Steam Calorimetry.	Concept of Mollier charts – Various Thermodynamic processes and energy Transfer – Steam Calorimetry.	https://tinyurl.com/kf2fj3xe	https://tinyurl.com/e5ynujwz	https://projectabstracts.com/tag/thermodynamics			Engineering Thermodynamics / PK Nag /TMH, 5th Edition
33			Perfect Gas Laws – Equation of State, specific and Universal Gas constants –	Concept of Perfect Gas Laws – Equation of State, specific and Universal Gas constants –	https://tinyurl.com/kf2fj3xe	https://tinyurl.com/e5ynujwz	https://projectabstracts.com/tag/thermodynamics	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition

34			various Non-flow processes, properties, end states, Heat and Work Transfer, changes in Internal Energy –	Concept of various Non-flow processes, properties, end states, Heat and Work Transfer, changes in Internal Energy –	https://tinyurl.com/kf2fj3xe	https://tinyurl.com/e5ynujwz	https://projectabstracts.com/tag/thermodynamics	Application	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
35				STUDENT PPT						
36			Heat and Work Transfer, changes in Internal Energy –	Concept of Heat and Work Transfer, changes in Internal Energy –	https://tinyurl.com/kf2fj3xe	https://tinyurl.com/e5ynujwz	https://projectabstracts.com/tag/thermodynamics	Application	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
37			Throttling and Free Expansion Processes – Flow processes	Concept ofThrottling and Free Expansion Processes – Flow processes	https://tinyurl.com/kf2fj3xe	https://tinyurl.com/e5ynujwz	https://projectabstracts.com/tag/thermodynamics	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
38			Flow processes	Derivation of various Flow processes	https://tinyurl.com/kf2fj3xe	https://tinyurl.com/e5ynujwz	https://projectabstracts.com/tag/thermodynamics			Engineering Thermodynamics / PK Nag /TMH, 5th Edition
39	IV		perfect Gas Model – Vader Waals Equation of State	Deviations from perfect Gas Model – Vader Waals Equation of State	https://tinyurl.com/jjk27e5u	https://tinyurl.com/4a4wkmpw	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics			Engineering Thermodynamics / PK Nag /TMH, 5th Edition
40				STUDENT PPT						
41			Compressibility charts	Compressibility charts – variable specific Heats	https://tinyurl.com/jjk27e5u	https://tinyurl.com/4a4wkmpw	https://www.skyfilabs.com/project-ideas/latest-	Study	PPT, CHALK N BOA	Engineering Thermodynamics / PK Nag /TMH, 5th Edition

				– Gas Tables			projects-based-on-Thermodynamics		RD, VIDEOS	
42			Mixtures of perfect Gases	Mixtures of perfect Gases – Mole Fraction, Mass friction Gravimetric and volumetric Analysis	https://tinyurl.com/jjk27e5u	https://tinyurl.com/4a4wkmpw	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
43			Dalton's Law of partial pressure, Avogadro's Laws of additive volumes	Concepts of Dalton's Law of partial pressure, Avogadro's Laws of additive volumes	https://tinyurl.com/jjk27e5u	https://tinyurl.com/4a4wkmpw	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics	Understand	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
44			Mole fraction, Volume fraction and partial pressure, Equivalent Gas const.	Concept of Mole fraction, Volume fraction and partial pressure, Equivalent Gas const.	https://tinyurl.com/jjk27e5u	https://tinyurl.com/4a4wkmpw	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
45				STUDENT PPT						
46			Molecular Internal Energy, Enthalpy, sp. Heats and Entropy of Mixture of perfect Gases and Vapour, Atmospheric air -	Concept of Molecular Internal Energy, Enthalpy, sp. Heats and Entropy of Mixture of perfect Gases and Vapour, Atmospheric air -	https://tinyurl.com/jjk27e5u	https://tinyurl.com/4a4wkmpw	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics	Study	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition

47			Psychrometric Properties	Definations of Dry bulbTemperature, Wet Bulb Temperature, Dew point Temperature, Thermodynamic Wet Bulb Temperature, Specific Humidity, Relative Humidity	https://tinyurl.com/jjk27e5u	https://tinyurl.com/4a4wkmpw	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
48			Saturated Air, Vapour pressure, Degree of saturation –	Concept of Saturated Air, Vapour pressure, Degree of saturation –	https://tinyurl.com/jjk27e5u	https://tinyurl.com/4a4wkmpw	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics			Engineering Thermodynamics / PK Nag /TMH, 5th Edition
49			Adiabatic Saturation, Carrier's Equation	Concept of Adiabatic Saturation, Carrier's Equation	https://tinyurl.com/jjk27e5u	https://tinyurl.com/4a4wkmpw	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics			ering Thermodynamics / PK Nag /TMH, 5th Edition
50				STUDENT PPT						
51			Psychrometric chart	Psychrometric chart-Related Problems	https://tinyurl.com/jjk27e5u	https://tinyurl.com/4a4wkmpw	https://www.skyfilabs.com/project-ideas/latest-projects-based-on-Thermodynamics	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
52	V		Power Cycles	Otto, Diesel, Dual Combustion cycles, Description and representation on P–V and T-S diagram,	https://tinyurl.com/v7vd5k55	https://tinyurl.com/5beku3dc	https://mechanical.mini-projects.in/c/thermodynamics-projects	Understand	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition

53			Sterling Cycle, Atkinson Cycle, Ericsson Cycle,	Description and representation on P–V and T-S diagram,	https://tinyurl.com/v7vd5k55	https://tinyurl.com/5beku3dc	https://mechanical.mini-projects.in/c/thermodynamics-projects	Application	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
54			Lenoir Cycle – Description and representation on P–V and T-S diagram,	Description and representation on P–V and T-S diagram,	https://tinyurl.com/v7vd5k55	https://tinyurl.com/5beku3dc	https://mechanical.mini-projects.in/c/thermodynamics-projects	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
60				STUDENT PPT						
56			Thermal Efficiency, Mean Effective Pressures on Air standard basis – comparison of Cycles.	Concept and derivation of Thermal Efficiency, Mean Effective Pressures on Air standard basis – comparison of Cycles. Problems	https://tinyurl.com/v7vd5k55	https://tinyurl.com/5beku3dc	https://mechanical.mini-projects.in/c/thermodynamics-projects	Study	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
57			Refrigeration Cycles	Brayton and Rankine cycles, Performance Evaluation	https://tinyurl.com/v7vd5k55	https://tinyurl.com/5beku3dc	https://mechanical.mini-projects.in/c/thermodynamics-projects	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
58			combined cycles, Bell-Coleman cycle,	Working of combined cycles	https://tinyurl.com/v7vd5k55	https://tinyurl.com/5beku3dc	https://mechanical.mini-projects.in/c/thermodynamics-projects	Application	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition

59			Bell-Coleman cycle,	Working of Bell-Coleman cycle	https://tinyurl.com/v7vd5k55	https://tinyurl.com/5beku3dc	https://mechanical.mini-projects.in/c/thermodynamics-projects	Application	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition
60				STUDENT PPT						
61			Vapour compression cycle-performance Evaluation.	Working of Vapour compression cycle-performance Evaluation.	https://tinyurl.com/v7vd5k55	https://tinyurl.com/5beku3dc	https://mechanical.mini-projects.in/c/thermodynamics-projects	Understand	PPT, CHALK N BOARD	
62			Problems	Related Problems	https://tinyurl.com/v7vd5k55	https://tinyurl.com/5beku3dc	https://mechanical.mini-projects.in/c/thermodynamics-projects	Explain	PPT, CHALK N BOARD, VIDEOS	Engineering Thermodynamics / PK Nag /TMH, 5th Edition

TEXT BOOKS:

1. **Engineering Thermodynamics / PK Nag /TMH, 5th Edition**
2. **Thermodynamics – An Engineering Approach by Cengel & Boles , McGraw Hill 8th Edition**

REFERENCE BOOKS:

1. Engineering Thermodynamics/DPMishra/Cengage Learning/Second impression 2012
2. Engineering Thermodynamics/E Rathakrishnan/PHI/Second Edition/2013
3. Thermodynamics – J.P.Holman / McGrawHill
4. Engineering Thermodynamics – Jones & Dugan
5. Engineering Thermodynamics/P.Chattopadhyay/Oxford Higher Education/Revised First Edition
6. Thermodynamics & Heat Engines – Yadav – Central Book Depot, Allahabad

X. QUESTION BANK (JNTUH)

DESCRIPTIVE QUESTIONS:

Unit-I

S. No.	Question	Blooms Taxonomy Level	Course Outcome
1	**Differentiate** the system, surroundings and boundary Explain in detail.	Analyze	1

2	**Classify** the types of systems, explain the energy conversion in them.	Understand	1
3	**Explain** in detail the macroscopic and microscopic study of thermodynamics?	Understand	1
4	**Explain** the importance of concept of continuum in thermodynamic approach?.	Understand	1
5	**Explain** thermodynamic equilibrium in detail?.	Understand	1
6	**Differentiate** thermal equilibrium and thermodynamic equilibrium, explain. .	Understand	2
7	**Explain,** the role of chemical equilibrium in thermodynamic equilibrium?	Understand	1
8	When a stationary mass of gas was compressed without friction at constant pressure, its initial state of $0.4m^3$ and 0.105MPa was found to change to final state of $0.20m^3$ and 0.105MPa. There was a transfer of 42.5kJ of heat from the gas during the process. **Determine** the change in internal energy of the gas?	Analyse	2
9	Two thermometers one centigrade and other Fahrenheit are immersed in a fluid, after the thermometers reached equilibrium with the fluid, it is noted that both the thermometers indicate the same numerical values. Find that the identical numerical values shown by the thermometers? Determine the corresponding temperature of the fluid, express in degrees Kelvin and degrees Rankine?	Analyse	2
10	A piston cylinder device operates 1kg of fluid at 20atm pressure with initial volume is $0.04m^3$. Fluid is allowed to expand reversibly following $pV^{1.45}=C$. So that the volume becomes double. The fluid is cooled at constant pressure until the piston comes back. **Determine** the work done in each process?	Analyse	2

Unit-II

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1	**Explain** the limitations of First law of thermodynamics in detail?	Understand	3
2	**Explain** the Joule's experiment with a neat sketch?	Understand	2
3	**Sketch** the constant volume gas thermometer and explain?	Apply	2
4	**List** the scales of temperature and explain in detail?	Understand	2
5	**Compare** the first law of thermodynamics with its corollaries?	Analyze	3
6	**Explain** how the first law of thermodynamics applied to a process?	Understand	3
7	**Explain** the Steady state flow equation ?	Understand	2
8	**Explain** the second law of thermodynamics with suitable sketches?	Understand	3
9	**Write** the Kelvin-Plank statement and explain with an example?	Understand	3
10	**State** the Third law of thermodynamics? Explain the importance	Remember	3
11	**Discuss** the equivalent of Kelvin-Plank and Clausius statements?	Understand	2
12	1kg of ice at -5^0C expose to the atmosphere which, is at 20^0C. The ice melts and comes into thermal equilibrium with the atmosphere. **Determine** the entropy increase of Universe. Cp for ice is 2.039 kJ/kgK, and the enthalpy of fusion of ice is 333.3kJ/kg.	Analyze	3
13	Heat flows from a hot reservoir at 800K to another reservoir at 250K.If the entropy change of overall process is 4.25kJ/K, **Compare** calculation for the heat flowing out of the high temperature reservoir?	Analyze	3

Unit-III

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1	**Define** Pure Substance and what do you understand by a saturation stage?	Understand	5
2	**Draw** the phase diagram on p-v diagrams with water as pure substance?	Understand	5
3	**Explain** the concept of p-v-T surface? Represent on p-T coordinates?	Understand	5
4	**Explain** the process of free expansion?	Understand	5
5	**Explain** the process of Throttling?	Understand	5
6	**Explain** Mollier chart by representing all the properties on it?	Understand	5
7	**State** the degree of superheat and degree of sub cooling?	Understand	5
8	A vessel of volume $0.04m^3$ contains a mixture of saturated water and saturated steam at a temperature of 250^0C. The mass of the liquid present is 9kg.**Find** the pressure, mass, specific volume, enthalpy, entropy and internal energy?	Analyze	5
9	**Determine** the enthalpy and entropy of steam and the pressure is 2MPa and the specific volume is $0.09m^3/kg$.	Analyze	5
10	Saturated steam has entropy of 6.76kJ/kg K. **Determine** the pressure, temperature, specific volume, enthalpy and internal energy?	Analyze	3

Unit-IV

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1	**State** Dalton's law of partial pressures?	Understand	4
2	**Explain** the equation of state?	Understand	5
3	**Derive** the changes in internal energy during a process with variable specific heats.	Understand	3
4	**Derive** the changes in enthalpy during a process with variable specific heats.	Understand	5
5	**Explain** On what coordinates compressibility charts can be drawn	Understand	3
6	**List** the molar specific heats, explain?	Understand	3
7	**Derive** the expression for internal energy?	Understand	3
8	**Define** mole fraction?	Understand	5
9	The **analysis** by weight of a perfect gas mixture at 20^oC and 1.3bar is $10\%O_2$, $70\%N_2$, $15\%CO_2$ and $5\%CO$. For a reference state of 0^0C and 1bar, **determine** partial pressure of the constituent and gas constant of mixture.	Analyze	6
10	Air at 20^0C,40% RH is mixed adiabatically with air at 40^0C, 40%RH in the atio of 1kg of the former with 2kg of later(on dry basis).**Find** the final condition of air?	Analyze	6

Unit-V

S.No.	Question	Blooms Taxonomy Level	Course Outcome
1	**Draw** the PV and TS diagram of Atkinson Cycle?	Understand	5
2	**Draw** the PV and TS diagram of Ericsson Cycle?	Understand	5
3	**Draw** the PV and TS diagram of Lenoir Cycle?	Understand	5
4	**Define** vapor compression cycle?	Understand	5
5	**Draw** the PV and TS diagram of Sterling Cycle?	Understand	5
6	**Compare** the thermal efficiency and mean effective pressure of Otto and diesel cycles?	Understand	5
7	**Compare** the thermal efficiency and mean effective pressure of dual and diesel cycles?	Understand	5
8	**Examine** the performance of Bell-Coleman cycle?	Analyze	5
9	An engine working on Otto cycle has a volume of $0.45m^3$ pressure 1bar and temperature 30^0C at the beginning of the compression stroke. At the end of the compression stroke the pressure is 11bar. 210kJ of heat is added at constant volume. **Determine** efficiency and mean effective pressure?	Analyze	5
10	A Bell-Coleman refrigerator operates between pressure limits of 1bar and 8bar. Air is drawn from the cold chamber at 9^0C, compressed and then it is cooled to 29^0C before entering the expansion cylinder. Expansion and compression follow the law $pV^{1.35}$=C. **Calculate** theoretical C.O.P of the system. Take γ of air is 1.4.	Analyze	5

<u>XI. OBJECTIVE QUESTIONS</u>

UNIT-1

1. A thermodynamic system is referred to be an isolated system when there is transfer of __________across the boundaries. [ ]
   (A) only mass B) only energy C) both mass and energy D) neither mass nor energy
2. Which one of the following represents open thermodynamic system? [ ]
   (A) Manual ice cream freezer (B) Centrifugal pump
   (C) Pressure cooker (D) Bomb calorimeter
3. A thermodynamic system is considered to be an isolated one if [ ]
   (A) Mass transfer and entropy change are zero
   (B) Entropy change and energy transfer are zero
   (C) Energy transfer and mass transfer are zero
   (D) Mass transfer and volume change are zero
4. A closed system is one in which [ ]
   (A) Mass does not cross boundaries of the system, though energy may do so
   (B) Mass crosses the boundary but not the energy
   (C) Neither mass nor energy cross the boundary of the system
   (D) Both energy and mass cross the boundaries of the system
5. Which one of the following is the extensive property of a thermodynamic system? [ ]
   A) Volume B) pressure C) temperature D) density

6. Work transfer between the system and the surroundings
   (A) Is a point function (B) Is always given by $\int Pdv$
   (C) Is a function of pressure only (D) depends on the path followed by the system?
7. A path function quantity is ___________ [ ]
   (A)Pressure (B) Temperature (C) Enthalpy (D) Heat
8. In highly rarefied gases, the concept of this loses validity
   (A) Thermodynamic equilibrium (B) continuum (C) stability (D) Macroscopic view point
9. Absolute zero temperature is taken as [ ]
   (a) – 273°C (b) 273°C (c) 237°C (d) – 373°C.
10. The amount of heat required to raise the temperature of 1 kg of water through 1°C is called [ ]
    (A) specific heat at constant volume (B)specific heat at constant pressure
    (C) kilo calorie (D)none of the above.
11. A series of operations, which take place in a certain order and restore the initial condition is known as [ ]
    (A) reversible cycle (B) irreversible cycle (C) thermodynamic cycle (D)none
12. The condition for the reversibility of a cycle is
    (A) the pressure and temperature of the working substance must not differ, appreciably, from those of the surroundings at any stage in the process [ ]
    (B) all the processes, taking place in the cycle of operation, must be extremely slow
    (C) the working parts of the engine must be friction free [ ]
    (D) there should be no loss of energy during the cycle of operation
    (E) all of the above (F) none of the above.
13. In an irreversible process, there is a [ ]
    (A) loss of heat (B) no loss of heat (C) gain of heat (D) no gain of heat.
14. The thermometric property for a constant volume gas thermometer is [ ]
    (A) Pressure B) volume (C) resistance D) length
15. Energy can be neither created nor destroyed, but it can be transformed from one form to another. This statement is known as [ ]
    (A) Zeroth law of thermodynamics B) first law of thermodynamics
    (C) second law of thermodynamics D) kinetic theory of gases
16. A perpetual motion machine of first kind is represented by [ ]
    (A) Fully reversible engine B) an engine with 100% thermal efficiency
    (C) A machine that continuously creates its own energy
    (D) A machine that is capable of transferring heat energy from a system at low temperature to a system at high temperature
17. A PMM I is _____ [ ]
    (A)Impossible according to second law of thermodynamics
    (B) Possible according to first law of
    (C) Impossible according to first law of thermodynamics

(D) Possible according to second law of thermodynamics

18. The temperature of a gas is the measure of _______________ [ ]
    (A)Average kinetic energy of gas molecules (B) Average distance between gas molecules
    (C) Average potential energy of gas molecules (D) None
19. Which one of the following statements is not correct? In a transient flow process [ ]
    (A) The rates of inflow and outflow of mass are different
    (B) The state of matter inside the control volume varies with time
    (C) There can be heat and work interactions across the control volume
    (D) There is no accumulation of energy inside the control volume

UNIT-2

1. In a Carnot cycle, the rejection of heat is [ ]
   (A) At constant pressure B) at constant volume C) at constant temperature
   D) Partly at constant pressure and partly at constant volume
2. Availability of a system at any given state is [ ]
   (A) a property of the system B) total energy of the system
   (C) maximum work obtainable as the system goes to dead state
   D) Maximum useful work obtainable as the system goes to dead state
3. For a thermodynamic cycle to be reversible, it is necessary that [ ]
   A) cyclic integral of ?Q/T = 0 B) cyclic integral of ?Q/T < 0
   (C) Cyclic integral of ?Q/T > 0 D) cyclic integral of ?Q/T ? 0
4. Second law of thermodynamics gives the concept of [ ]
   (A) Work (B) heat (C) internal energy (D) entropy
5. In a reversible process, the change in entropy is [ ]
   (A) Zero (B) minimum (C) maximum (D) unity
6. Increase in entropy of a system represents [ ]
   (A) Increase in availability of energy (B) Increase in temperature
   (C) Decrease in pressure (D) Degradation of energy
7. Gibb's function is expressed as ______ [ ]
   (A) H-TS (B) U-TS (C)H+TS (D) U+TS
8. A refrigerator operates between the temperatures of -23 ºC and 27 ºC. If one TR = 3.5 kW, the minimum power required per TR to operate the refrigerator is [ ]
   (A) 0.5 kW (B) 0.7 kW (C) 0.9 kW (D) 1.0 kW
9. Efficiency of a Carnot engine is 75%. If the cycle direction is reversed, COP of the reversed Carnot cycle is [ ]
   (A) 1.33 (B) 0.75 (C) 0.33 (D) 1.75
10. The continual motion of a movable device in absence of friction
    (A) Violates the first law of thermodynamics
    (B) Violates the second law of thermodynamics
    (C) Is the perpetual motion of the second kind?
    (D) Is the perpetual motion of the third kind?

11. For a given temperature T_1 as the difference between T_1 and T_2 increase, the COP of a Carnot heat pump
(A) Increases (B) decreases (C) does not change (D) first decrease, then increases
12. A heat engine is supplied with 2515kJ/min of heat at 650°C. Heat rejection with 900kJ/minute takes place at 100°C. This type of heat engine is [ ]
(A) Ideal (B) irreversible (C) impossible (D) practical
13. When a system reaches the state of equilibrium, the following property assumes its maximum value
(A) Availability (B) Entropy (C) Gibbs function (D) Helmholtz function
14. 100kJ of energy is transferred from a heat reservoir at 1000K to a heat reservoir at 500k. The ambient temperature is 300K. The loss of available energy due to heat transfer process is
(A) 20kJ (B) 30kJ (C) 40kJ (D) 50kJ

UNIT-3

1. At triple point of a pure substance [ ]
(A) liquid and vapour phases co-exist B) Solid and vapour phases co-exist
(C) liquid and solid phases co-exist D) Solid, liquid and vapour phases co-exist
2. Mollier diagram is drawn between [ ]
(A) p-V B) T-S C) h-s D) p-T
3. Heat supplied to a system equals the work done in case of a non-flow process carried out
(A) Isochorically (B) Isobarically (C)Isothermally (D)Adiabatically
4. Only throttling calorimeter is used for measuring [ ]
(A) Very low dryness fraction up to 0.7 (B) very high dryness fraction up to 0.98
(C) Dryness fraction of only low pressure steam (D) dryness fraction of only high pressure steam
5. Air is being forced by the bicycle pump into a tyre against a pressure of 4.5 bars. A slow downward movement of the piston can be approximated as' [ ]
(A) Isobaric process (B) Adiabatic process (C) Throttling process (D) Isothermal process
6. Isentropic flow is [ ]
(A) Irreversible adiabatic flow (B) Reversible adiabatic flow
(C) Ideal fluid flow (D) Frictionless reversible flow
7. Reduced pressure is [ ]
(A) Always less than atmospheric pressure (B) Always unity
(C) An index of molecular position of a gas (D) Dimensionless
8. State of a wet vapour cannot be specified only by [ ]
(A) Pressure and temperature (B) Pressure and dryness fraction
(C) Temperature and dryness fraction (D) Pressure and volume
9. In which of the following processes, the heat is fully converted into work?
(A) Reversible adiabatic process (B) Reversible isobaric process (C) Reversible isometric process (D) Reversible isothermal process

10. Consider the following statements for a throttling process: 1. It is an adiabatic process 2. There is no work transfer in the process 3. Entropy increases in throttling process. Which of these statements are correct?
    (A) 1, 2 and 3 (B) 1 and 2 only (C) 2 and 3 only (D) 1 and 3 only
11. For steady flow through an insulated horizontal constant pipe, this property remains constant
    (A) Enthalpy (B) Internal energy (C) Entropy (D) Volume
12. The difference between constant pressure specific heat C_p and constant volume specific heat C_v for pure substance
    (A) approaches zero at triple point
    (B) approaches zero as the absolute temperature approaches zero
    (C) is always equal to the gas constant R
    (D) approaches zero at critical point

UNIT -4

1. Which of the following variables controls the physical properties of a perfect gas [ ]
   (A) pressure (B)temperature (C) volume (D)all of the above
2. Gas laws are applicable to _________ [ ]
   (A) gases as well as vapours (B) gases alone and not to vapours
   (C) gases and steam (D) none of the above
3. The ratio of two specific heats of air is equal to ____________ [ ]
   (A) 0.17 (B) 0.24 (C) 0.37 (D) 1.41
4. The statement that molecular weights of all gases occupy the same volume is known as
   (A) Avogadro's hypothesis (B) Dalton's law (C) Gas law (D) Joule's Law
5. On volume basis, air contains following percentage of oxygen________ [ ]
   (A) 21 (B) 23 (C)25 (D)77
6. In air-water vapour mixture, the partial pressure of water vapour corresponds to the saturation temperature called
   (A) Dew point temperature (B) Wet bulb temperature
   (C) Dry bulb temperature (D) Adiabatic saturation temperature
7. A certain air has DBT of 35ºC and DPT of 20ºC, the corresponding saturation pressure of water being 5.628 kPa and 2.33 kPa respectively. When the atmospheric pressure is assumed as 1.0132 bar, the specific humidity of air will be
   (A) 2.5×10^{-3}(B) 7.8×10^{-3} (C) 14.7×10^{-3} (D) 25×10^{-3}
8. There is no work transfer involved in this process
   (A) Adiabatic expansion (B) Isothermal expansion
   (C) Polytropic expansion (D) Free expansion
9. In which of the following processes, the heat is fully converted into work?
   (A) Reversible adiabatic process (B) Reversible isobaric process
   (C) Reversible isometric process (D) Reversible isothermal process

UNIT -5

1. Thermal power plant works on _______ cycle.
   (A) Carnot (B) Joule (C) Rankine (D) Otto
2. Otto cycle consists of following four processes ____________.
   (A) two isothermals and two isentropics
   (B) two isentropics and two constant volumes
   (C) two isentropics and one constant volume and one constant pressure
   (D) two isentropics and two constant pressures
3. A Bell-Coleman cycle is a reversed __________ cycle. [ ]
   (A) otto (B) Carnot (C) stirling (D) Joule
4. The effects of superheating of vapour in the evaporator and sub cooling of condensate in the condenser, for the same compressor work is:
   (A) Increase the COP
   (B) Decrease the COP
   (C) Superheating increases COP, but sub cooling decreases COP
   (D) Superheating decreases COP, but sub cooling increases COP
5. The cycle in which heat is supplied at constant volume and rejected at constant pressure is known as [ ]
   (A) Dual combustion cycle (B) Diesel cycle (C) Atkinson cycle (D) Rankine cycle
6. This reversible cycle consists of constant volume heat addition, reversible adiabatic expansion and constant pressure heat rejection
   (A) Otto cycle (B) Lenoir cycle (C) Atkinson cycle (D) Brayton cycle
7. The COP of a refrigerator working on a reversed Carnot cycle is 5. The ratio of the highest absolute temperature to the lowest absolute temperature would be
   (A) 1.25 (B) 1.3 (C) 1.4 (D) 1.2
8. An ideal vapour compression refrigerator operates between a condenser pressure p_1 and an evaporator pressure p_2. Which of the following changes would increase its COP?
   (A) Increasing p_1 by Δp and keeping p_2 constant
   (B) Decreasing p_2 by Δp and keeping p_1 constant
   (C) Adopting wet compression (D) Subcooling the refrigerant

ii) GATE QUESTIONS:

1. The maximum theoretical work obtainable, when a system interacts to equilibrium with a reference environment, is called _______.
   (A) Entropy (B) Enthalpy (C) Exergy (D) Rothalpy
2. 1.5 kg of water is in saturated liquid state at 2 bar (v_f = 0.001061 m3/kg, u_f= 504.0 kJ/kg, h_f= 505 kJ/kg). Heat is added in a constant pressure process till the temperature of water reaches 400°C (v = 1.5493 3 m / Kg, u = 2967.0 kJ/kg, h = 3277.0 kJ/kg). The heat added (in kJ) in the process is _______.
3. In an air-standard Otto cycle, air is supplied at 0.1 MPa and 308 K. The ratio of the specific heats (γ) and the specific gas constant (R) of air are 1.4 and 288.8 J/kg.K,

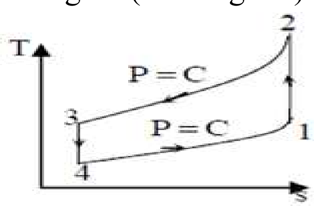
respectively. If the compression ratio is 8 and the maximum temperature in the cycle is 2660 K, the heat (in kJ/kg) supplied to the engine is _______.

4. A reversible heat engine receives 2 kJ of heat from a reservoir at 1000 K and a certain amount of heat from a reservoir at 800 K. It rejects 1 kJ of heat to a reservoir at 400 K. The net work output (in kJ) of the cycle is
   (A) 0.8 (B) 1.0 (C) 1.4 (D) 2.0
5. The thermal efficiency of an air-standard Brayton cycle in terms of pressure ratio r_p and γ is given by
   (A) $1-\frac{1}{r_p^{r-1}}$ (B) $1-\frac{1}{r_p^{r}}$ (C) $1-\frac{1}{r_p^{1/r}}$ (D) $1-\frac{1}{r_p^{(\gamma-1)/\gamma}}$
6. A pure substance at 8 MPa and 400ºC is having a specific internal energy of 2864 kJ/kg and a specific volume of 0.03432 m^3/ kg. Its specific enthalpy (in kJ/kg) is _______.
7. In an ideal Brayton cycle, atmospheric air (ratio of specific heats, c_p/c_v = 1.4, specific heat at constant pressure = 1.005 kJ/kg.K) at 1 bar and 300 K is compressed to 8 bar. The maximum temperature in the cycle is limited to 1280 K. If the heat is supplied at the rate of 80 MW, the mass flow rate (in kg/s) of air required in the cycle is _______.
8. Which one of the following pairs of equations describes an irreversible heat engine?
   (A) $\oint \delta Q > 0$ and $\oint \frac{\delta Q}{T} < 0$ (B) $\oint \delta Q < 0$ and $\oint \frac{\delta Q}{T} < 0$
   (C) $\oint \delta Q > 0$ and $\oint \frac{\delta Q}{T} > 0$ (D) $\oint \delta Q < 0$ and $\oint \frac{\delta Q}{T} > 0$
9. A source at a temperature of 500K provides 1000kJ of heat. The temperature of environment is 27ºC. The maximum useful work (in kJ) that can be obtained from the heat source is _______.
10. A sample of moist air at a total pressure of 85 KPa has a dry bulb temperature of 30°C (saturation vapour pressure of water = 4.24 KPa). If the air sample has a relative humidity of 65%, the absolute humidity (in gram) of water vapour per kg of dry air is _______.
11. A certain amount of an ideal gas is initially at a pressure P1 and temperature $T1$. First, it undergoes a constant pressure process 1-2 such that $T2 = 3T1/4$. Then, it undergoes a constant volume process 2-3 such that $T3 = T1/2$. The ratio of the final volume to the initial volume of the ideal gas is
    (A) 0.25 (B) 0.75 (C) 1.0 (D) 1.5
12. A diesel engine has a compression ratio of 17 and cut-off take place at 10% of the stroke. Assuming ratio of specific heats (γ) as 1.4, the air-standard efficiency (in percent) is _______.
13. An air-standard Diesel cycle consists of the following processes: 1-2: Air is compressed isentropically. 2-3: Heat is added at constant pressure. 3-4: Air expands isentropically to the original volume. 4-1: Heat is rejected at constant volume. If γ denotes the specific heat ratio and T temperature, respectively the efficiency of the cycle is

(A) $1-[(T_4-T_1)/(T_3-T_2)]$ (B) $1-[(T_4-T_1)/\gamma(T_3-T_2)]$
(C) $1-[\gamma (T_4-T_1)/(T_3-T_2)]$ (D) $1-[(T_4-T_1)/(\gamma -1)(T_3-T_2)]$

14. A rigid container of volume 0.5 m^3 contains 1.0 kg of water at 120°C (v_f = 0.00106 m^3/kg, v_g = 0.8908 m^3/kg). The state of water is _______.
(A) Compressed liquid (B) Saturated liquid (C) A mixture of saturated liquid and saturated vapor (D) Superheated vapor

15. The thermodynamic cycle shown in figure (T/s diagram) indicates:



(A) Reversed Cannot cycle (B) Reversed Brayton cycle
(C) Vapor compression cycle (D) Vapor absorption cycle

16. An air-standard Diesel cycle consists of the following processes: 1-2: Air is compressed isentropically. 2-3: Heat is added at constant pressure. 3-4: Air expands isentropically to the original volume. 4-1: Heat is rejected at constant volume. If γ denotes the specific heat ratio and T temperature, respectively the efficiency of the cycle is
(A) $1-[(T_4-T_1)/(T_3-T_2)]$ (B) $1-[(T_4-T_1)/\gamma(T_3-T_2)]$
(C) $1-[\gamma (T_4-T_1)/(T_3-T_2)]$ (D) $1-[(T_4-T_1)/(\gamma -1)(T_3-T_2)]$

17. Air in a room is at 35° and 60% relative humidity (RH). The pressure in the room is 0.1 MPa. The saturation pressure of water at 35°C is 5.63 kPa. The humidity ratio of the air (in gram/kg of dry air) is _____.

18. For an ideal gas with constant values of specific heats, for calculation of the specific enthalpy,
(a) it is sufficient to know only the temperature
(b) both temperature and pressure are required to be known
(c) both temperature and volume are required to be known
(d) both temperature and mass are required to be known

19. A Carnot engine (CE-1) works between two temperature reservoirs *A* and *B*, where T_A = 900 K and T_B = 500 K. A second Carnot engine (CE-2) works between temperature reservoirs *B* and *C*, where T_C = 300 K. In each cycle of CE-1 and CE-2, all the heat rejected by CE-1 to reservoir *B* is used by CE-2. For one cycle of operation, if the net *Q* absorbed by CE-1 from reservoir *A* is 150 MJ, the net heat rejected to reservoir *C* by CE-2 (in MJ) is _________.

20. A stream of moist air (mass flow rate = 10.1 kg/s) with humidity ratio of 0.01kg per kg dry air mixes with a second stream of superheated water vapour flowing at 0.1 kg/s. Assuming proper and uniform mixing with no condensation, the humidity ratio of the final stream is ___________ kg per kg dry air.

21. Air enters a diesel engine with a density of 1.0 kg/m3. The compression ratio is 21. At steady state, the air intake is 30×10^{-3} kg/s and the net work output is 15 kW. The mean effective pressure (kPa) is _______.
22. The Vander Waals equation of state is $(p + a/ v^2) (v - b) = RT$ where p is pressure, v is specific volume, T is temperature and R is characteristic gas constant. The SI unit of a is
    (A) J/kg.K (B) m^3/kg (C) $m^5/kg\text{-}s^2$ (D) Pa/kg
23. The COP of a Carnot heat pump operating between 6ºC and 37ºC is ___________.
24. One kg of air (R = 287 J/kg.K) undergoes an irreversible process between equilibrium state 1 (20ºC, $0.6m^3$) and equilibrium state 2 (20ºC, $0.6m^3$). The change in entropy S2 – S1 (in J/kg.K) is _________
25. Work is done on an adiabatic system due to which its velocity changes from 10 m/s to 20 m/s, elevation increases by 20 m and temperature increases by 1K. The mass of the system is 10 kg. C_V =100J kg.K and gravitational acceleration is 10 m/s^2. If there is no change in any other component of the energy of the system, the magnitude of total work done (in kJ) on the system is ________.
26. A mixture of ideal gases has the following composition by mass:

N_2	O_2	CO_2
60%	30%	10%

    If the Universal gas constant is 8314 J/mol-K, the characteristic gas constant of the mixture (in J/kg.K) is _________.
27. For the same values of peak pressure, peak temperature and heat rejection, the correct order of efficiencies for Otto, Dual and Diesel cycles is
    (A) $\eta_{otto} > \eta_{Dual} > \eta_{Diesel}$ (B) $\eta_{Diesel} > \eta_{Dual} > \eta_{otto}$
    (C) $\eta_{Dual} > \eta_{Diesel} > \eta_{otto}$ (D) $\eta_{Diesel} > \eta_{otto} > \eta_{Dual}$

iii) IES QUESTIONS:

1. A body of mass 20kg falls freely in vacuum. It has fallen through a vertical distance of 50m. The gravitational acceleration may be assumed as $10ms^2$. What is the thermodynamic work done by the body?
   (A) 1000Nm (B) 10kJ (C) 0 (D) 1kNm
2. When a system is taken from state "x" to state "y", 30kJ of heat flows into the system and the system does 10kJ of work. When the system is returned from "y" to "x" along another path, work done on the system is 8 kJ. What is the amount of heat liberated or absorbed?
   (A) 12kJ of the heat liberated (B) 28 kJ of heat liberated
   (C) 12kJ of the heat absorbed (D) 28 kJ of heat absorbed
3. A closed gaseous system undergoes a reversible constant pressure process at 2 bar in which 100kJ of heat is rejected and the volume change from $0.2m^3$ to $0.1m^3$. The change in the internal energy of the system is
   (A) -100 kJ (B) -80 kJ (C) -60 kJ (D) -40 kJ

4. A Carnot engine receives 100kJ of heat at 600K. Heat is rejected at 300 K. The displacement volume is 0.2 m^3. The mean effective pressure is
   (A) 2 bar (B) 2.5 bar (C) 3 bar (D) 3.5 bar
5. The values of heat transfer and work transfer for the process of a thermodynamic cycle are given below:

Process	Heat transfer (kJ)	Work transfer (kJ)
1	300	300
2	00	250
3	-100	-100
4	00	-250

   The thermal efficiency of the cycle and the work ratio will be respectively:
   (A) 33% and 0.66 (B) 66% and 0.36 (C) 36% and 0.66 (D) 33% and 0.36
6. A body of mass 2kg and Cp = 1.00kJ/kg K is available at 600 K. If the atmosphere is 300K and ln(2) = 0.693, the maximum work obtainable from the body till it comes to equilibrium with the atmosphere is
   (A) 150kJ (B) 142kJ (C) 184.2kJ (D) 190.5kJ
7. A liquid of heat capacity 5 J/K in an insulated container is heated electrically from 300 K to 600 K. If In 2 = 0.693, entropy generation of the universe would be
   (A) 6.93 J/K (B) 3.465 J/K (C) 34.65 J/K (D) 10.65 J/K
8. Which of the following relationships represents the change of entropy of perfect gas?
   (i) Cp (dT/ T) + (R/V) dV (ii) Cp (dT / T) - (R/V) dP
   (iii) Cv (dP / P) + Cp (dV / V) (iv) Cp (dP / P) - Cv (dV / V)
   (A) 1, 2 and 4 only (B) 1, 2 and 3 only (C) 2, 3 and 4 only (D) 1, 2, 3 and 4
9. During a thermodynamic process, 100 kJ of heat is transferred from a reservoir at 800K to a sink at 400K. The ambient temperature is 300 K. The loss of available energy is
   (A) 27.5 kJ (B) 32.5kJ (C) 37.5kJ (D) 62.5kJ
10. A refrigerator that operates on a Carnot cycle is required to transfer 2000kJ/min to the atmosphere at 27^{o}C, where the low temperature reservoir is a 0^{o}C. What is the power required?
   (A) 200W (B) 32.93kW (C) 200kW (D) 3.33kW

XII. WEBSITES:

1. https://thermodynamics-engineer.com/
2. http://nptel.ac.in/video.php?subjectId=112105123
3. http://www.learnthermo.com/
4. http://esciencenews.com/dictionary/thermodynamics
5. http://research.omicsgroup.org/index.php/Thermodynamics

XIII. EXPERT DETAILS:

1. Prof. D. P. Mishra, Professor, IIT, Kanpur
2. Dr. A. V. S. S. K. S. Gupta, Professor, JNTU, Hyderabad

XIV. JOURNALS (National & International):

1. JOURNAL OF THERMDYNAMICS http://www.hindawi.com/journals/jther/

2. International Journal of Thermodynamics http://dergipark.ulakbim.gov.tr/eoguijt/
3. International Journal of Mechanics and Thermodynamics (IJMT) http://www.ripublication.com/irph/ijmt.htm

XV. LIST OF TOPICS FOR STUDENT SEMINARS:

1. Principles of thermometry
2. Limitations of the First Law
3. Perfect Gas Laws
4. Mixtures of Perfect Gases
5. Thermodynamic cycles

XVI. CASE STUDIES/SMALL PROJECTS:

1. Energy interactions in proof of First Law
2. IInd law of efficiencies for Heat engines.
3. Possible implementation of Thermodynamics power cycles
4. Exergy significance in design of thermal system.
5. Refrigeration cycles
6. Otto and diesel cycle

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