Ref No:

< SRI KRISHNA INSTITUTE OF TECHNOLOGY, BENGALURU>

COURSE PLAN

Academic Year 2019-20

Program:	B E – Mechanical Engineering
Semester :	3
Course Code:	18ME33
Course Title:	Basic Thermodynamics
Credit / L-T-P:	4 / 3-0-0
Total Contact Hours:	50
Course Plan Author:	B.M.Krishne Gowda

Academic Evaluation and Monitoring Cell

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Note : Remove “Table of Content” before including in CP Book
Each Course Plan shall be printed and made into a book with cover page
Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

18ME33: BASIC THERMODYNAMICS

A. COURSE INFORMATION

1. Course Overview

Degree:	BE	Program:	ME
Semester:	3	Academic Year:	2019-20
Course Title:	Basic Thermodynamics	Course Code:	18ME33
Credit / L-T-P:	4 / 3-0-0	SEE Duration:	180 Minutes
Total Contact Hours:	50 Hours	SEE Marks:	60 Marks
CIA Marks:	40 Marks	Assignment	1 / Module
Course Plan Author:	B.M.KRISHNE GOWDA	Sign ..	Dt:
Checked By:		Sign ..	Dt:
CO Targets	CIA Target : 80 %	SEE Target:	70.00%

Note: Define CIA and SEE % targets based on previous performance.

2. Course Content

Content / Syllabus of the course as prescribed by University or designed by institute. Identify 2 concepts per module as in G.

Module	Content	Teaching Hours	Identified Module Concepts	Blooms Learning Levels
1	**Fundamental Concepts & Definitions:** Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; Definition and units, intensive, extensive properties, specific properties, pressure, specific volume. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes. Thermodynamic equilibrium; definition mechanical equilibrium; Diathermic wall, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics. Temperature; concepts, scales, international fixed points and Measurement of temperature. Constant volume gas Thermometer, constant pressure gas thermometer, mercury in glass thermometer & Numerical problems.	10	Thermodynamic system and Temperature Scales	L3 Apply
2	**Work and Heat:** Mechanics, definition of work and its limitations. Thermodynamic definition of work; Examples, sign Convention. Displacement work; as a part of a system boundary, as a whole of a system boundary. Expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention. Numerical problems. **First Law of Thermodynamics:** Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy	10	Conservation of energy and Energy interaction	L3 Apply

	Extension of the First law to control volume; steady flow energy equation (SFEE), important applications.			
3	**Second Law of Thermodynamics:** Limitations of first law of thermodynamics Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir, Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficients of performance. Kelvin-Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics. Equivalence of the two statements; Carnot cycle, Carnot principles. Numerical problems. **Entropy:** Clausius inequality, Statement- proof. Entropy- definition, a property, changes of entropy, entropy as a quantitative test for irreversibility. Principle of increase in entropy, entropy as a coordinate. Numerical problems.	10	Nature of thermodynamic processes and Thermodynamic system properties	L3 Apply
4	**Availability, Ir-reversibility and General Thermodynamic relations:** Introduction, Availability (Energy), Unavailable energy, Relation between increase in unavailable energy and increase in entropy. Maximum work, maximum useful work for a system & control volume, Ir-reversibility, second law efficiency. Numerical problems. **Pure Substances:** P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid an water ad vapor, saturated vapor and superheated vapor states of pure substance withs example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables and its use. Throttling calorimeter, separating and throttling calorimeter. Numerical problems.	10	Thermodynamic relations and Properties of substance	L3 Apply
5	**Ideal gases:** Ideal gas mixtures, Daltons law of partial pressures. Amagat's law of additive volumes. Evaluation of properties of perfect and ideal gases. Air- Water mixtures and related properties. Numerical problems. **Real gases-**introduction, Van-der Wall's equation of state, Van-der Wall's constants in terms of critical properties. Beattie-Bridgeman equation. Law of corresponding states, compressibility factor; compressibility chart. Difference between ideal and real gases and Numerical problems.	10	Ideal gas properties and Real gas properties	L3 Apply
-	**Total**	**50**		**-**

3. Course Material

Books & other material as recommended by university (A, B) and additional resources used by course teacher (C).
1. Understanding: Concept simulation / video ; one per concept ; to understand the concepts ; 15 – 30 minutes
2. Design: Simulation and design tools used – software tools used ; Free / open source
3. Research: Recent developments on the concepts – publications in journals; conferences etc.

Modules	Details	Chapters in book	Availability
A	**Text books (Title, Authors, Edition, Publisher, Year.)**	-	-
1,2,3,4, 5	Fundamentals of thermodynamic, sixth edition by Sonnatag, Borgnakke and Van Wylen.	1, 2 3, 5	In Lib/ In dept.Lib
1,2,3,4, 5	Thermal Engg, by Domkundawar	1, 2, 4,5	In Lib/ In dept.Lib
B	**Reference books (Title, Authors, Edition, Publisher, Year.)**	-	-
1,2,3,4, 5	Basic and applied thermodynamic, Second edition by P.K.NAG	1, 2, 3,4,5	In Lib.
1,2,3,4, 5	Thermodynamics by Prasanna Kumar	1, 2, 3,4,5	In Lib.
C	**Concept Videos or Simulation for Understanding**	-	-
C1	https://freevideolectures.com/course/2681/basic-thermodynamics		
C2	https://nptel.ac.in/courses/112105123/		
C3	https://nptel.ac.in/courses/112105266/		
C4	https://ocw.mit.edu/courses/physics/8-333-statistical-mechanics-i-statistical-mechanics-of-particles-fall-2013/video-lectures/lecture-1-thermodynamics-part-1/		
C5	https://www.btechguru.com/GATE--mechanical-engineering--thermodynamics-video-lecture--23--194.html		
C6	http://web.sbu.edu/physics/courses/Physics-304.doc		
D	**Software Tools for Design**	-	-
	CFD--Fluent		
E	**Recent Developments for Research**	-	-

F	**Others (Web, Video, Simulation, Notes etc.)**	-	-
1	https://www3.nd.edu/~powers/ame.20231/notes.pdf		
2	https://www.cpp.edu/~pbsiegel/supnotes/nts1323.pdf		

4. Course Prerequisites

Refer to GL01. If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

Students must have learnt the following Courses / Topics with described Content . . .

Modules	Course Code	Course Name	Topic / Description	Sem	Remarks	Blooms Level
1	17PHY12	Physics	1. Applications of Physics laws	I		
	17MAT11	Mathematic	2. Application of simple Mathematic elements like integration and differentiation.	I	Plan Gap Course	

5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.

Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swayam videos etc.

Modules	Topic / Description	Area	Remarks	Blooms Level

1	17PHY12	Physics	1. Applications of Physics laws	I
2	17MAT11	Mathematic	2. Application of simple Mathematic elements like integration and differentiation.	I

B. OBE PARAMETERS

1. Course Outcomes

Expected learning outcomes of the course, which will be mapped to POs. Identify a max of 2 Concepts per Module. Write 1 CO per Concept.

Modules	Course Code.#	Course Outcome **At the end of the course, student should be able to . . .**	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
1	18ME33.1	Understand the thermodynamic systems and properties.	4	Thermodynamic system	Lecture	Assignment, Unit Test & CIE	L2 Understand
1	18ME33.2	Apply the above concepts to solve engineering problems.	6	Energy conversion	Lecture	Assignment, Unit Test & CIE	L3 Apply
2	18ME33.3	State the first law of thermodynamic system. write an expression for SFE Equation.	4	Conservation of energy	Lecture	Assignment, Unit Test & CIE	L3 Apply
2	18ME33.4	Interpret the energy interaction.	6	Energy interaction	Lecture	Assignment, Unit Test & CIE	L3 Apply
3	18ME33.5	Develop the nature of thermodynamic process.	4	Nature of thermodynamic processes	Lecture	Assignment, Unit Test & CIE	L3 Apply
3	18ME33.6	Illustrate the thermodynamic properties.	6	Thermodynamic system properties	Lecture	Assignment, Unit Test & CIE	L3 Apply
4	18ME33.7	Apply the thermodynamic relations.	5	Thermodynamic relations	Lecture	Assignment, Unit Test & CIE	L3 Apply
4	18ME33.8	Interpret the behavior of pure substance.	5	Properties of substance	Lecture	Assignment, Unit Test & CIE	L3 Apply
5	18ME33.9	Calculate thermodynamic properties of real gases at all ranges of pressure and temperature.	5	Ideal gas properties	Lecture	Assignment, Unit Test , & CIE	L3 Apply
5	18ME33.10	Calculate the thermodynamic properties of real gases at all ranges of pressure and temperature using modified equation.	5	Real gas properties	Lecture	Assignment unit test& CIE	L3 Apply
-	-	Total	**50**		-	-	**L2-L2**

2. Course Applications

Write 1 or 2 applications per CO.
Students should be able to employ / apply the course learning's to . . .

Modules	Application Area Compiled from Module Applications.	CO	Level
1	Thermodynamics system is a major part in the design field.	CO1	L2

2	Automobile, Locomotives, Ships,Submarines and Aircraft.	CO2	
3	Power generating plants.	CO3	L2
4	Energy interactions with atmosphere and with the earth surface play a vital role in Remote sensing.	CO4	L3
5	It is used extensively in the discussion of heat engines.	CO5	L2
6	Thermodynamic properties based applications are refrigerator, the humidifier, the pressure cooker, the water heater.	CO6	L3
7	Thermodynamic relation are used in thermal power plants.	CO7	L3
8	Air conditioning systems, the refrigerator, the humidifier etc	CO8	L3
9	Breathing Mechanics Breathing involves pressure differences between the inside of the lungs and the air outside.	CO9	L3

3. Mapping And Justification

CO – PO Mapping with mapping Level along with justification for each CO-PO pair.
To attain competency required (as defined in POs) in a specified area and the knowledge & ability required to accomplish it.

Modules	Mapping		Mapping Level	Justification for each CO-PO pair	Level
-	**CO**	**PO**	-	**'Area': 'Competency' and 'Knowledge' for specified 'Accomplishment'**	-
1	CO1	PO1	1	Knowledge of engineering science is required to understand the thermodynamic properties.	L1
1	CO1	PO2	2	Analyzing the different mechanisms in thermodynamic properties.	L3
1	CO1	PO3	3	Different process knowledge is required to design the solution.	L2
1	CO2	PO1	1	Applying the basic thermodynamic properties to solve the engineering problems.	L3
1	CO2	PO2	2	Analise the basic fundamental properties	L3
1	CO3	PO1	3	Knowledge of engineering science to understand the first law of thermodynamics.	L2
2	CO3	PO2	1	Analyzing first law of thermodynamics in different process.	L3
2	CO4	PO1	2	Knowledge of energy science is required to understand energy interactions.	L2
2	CO4	PO2	3	Analyzing the different energy interactions in the system.	L3
3	CO5	PO1	1	Knowledge of basic concepts of engineering fundamentals is required to develop the nature of thermodynamic process.	L3
3	CO5	PO2	2	Analiese the different thermodynamic processes.	L3
3	CO6	PO1	3	Knowledge of thermodynamic properties is required to understand thermodynamic relations.	L2
3	CO6	PO2	1	Analyzing the thermodynamic relations to different thermodynamic properties	L3
4	CO7	PO1	2	Knowledge of basic non conventional energy is required to understand the tidal and wave energy.	L2
4	CO7	PO2	3	Analyzing the problems in the different forms of wind and tidal energy.	L3
4	CO8	PO1	3	Knowledge of basic science is required to understand the behavior of pure substance of water.	L2
4	CO8	PO2	1	Analyzing the behavior of water with different states.	L3
5	CO9	PO1	2	Knowledge of basic engineering fundamentals required to understand the concepts of fuel cell.	L2
5	CO9	PO2	3	Analyzing the different fuel cell principles.	L3
5	CO10	PO1	1	Knowledge of basic properties of gas is required to understand the concepts of behavior of gases in different ranges.	L3

5	CO10	PO2	2	Analyzing the different thermodynamic properties of different gases..	L3

4. Articulation Matrix

CO – PO Mapping with mapping level for each CO-PO pair, with course average attainment.

-	-	Course Outcomes	Program Outcomes															-
Modules	CO.#	**At the end of the course student should be able to . . .**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	Level
1	18ME33.1	Understand the thermodynamic systems and properties.	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-	L2
1	18ME33.2	Apply the above concepts to solve engineering problems.	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-	L3
2	18ME33.3	State the first law of thermodynamic system. write an expression for SFE Equation.	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-	L2
2	18ME33.4	Interpret the energy interaction.	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-	L3
3	18ME33.5	Develop the nature of thermodynamic process.	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-	L3
3	18ME33.6	Illustrate the thermodynamic properties.	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-	L3
4	18ME33.7	Apply the thermodynamic relations.	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-	L3
4	18ME33.8	Interpret the behavior of pure substance.	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-	L3
5	18ME33.9	Calculate thermodynamic properties of real gases at all ranges of pressure and temperature.	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-	L3
5	18ME33.10	Calculate the thermodynamic properties of real gases at all ranges of pressure and temperature using modified equation.	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-	L3
-	**17ME53**	**Average attainment (1, 2, or 3)**																
-	*PO, PSO*	*1.Engineering Knowledge; 2.Problem Analysis; 3.Design / Development of Solutions; 4.Conduct Investigations of Complex Problems; 5.Modern Tool Usage; 6.The Engineer and Society; 7.Environment and Sustainability; 8.Ethics; 9.Individual and Teamwork; 10.Communication; 11.Project Management and Finance; 12.Life-long Learning; S1.Software Engineering; S2.Data Base Management; S3.Web Design*																

5. Curricular Gap and Content

Topics & contents not covered (from A.4), but essential for the course to address POs and PSOs.

Modules	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
2,3,4	Application of Turbomachines	Seminar	--	----	po3

6. Content Beyond Syllabus

Topics & contents required (from A.5) not addressed, but help students for Placement, GATE, Higher Education, Entrepreneurship, etc.

Modules	Gap Topic	Area	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1	Automated machine tools	Placement, GATE, Higher Study, Entrepreneurship.	Presentation	17th May 2019	Mr. Hanumatharaju, Dynamatic Industries	PO1

C. COURSE ASSESSMENT

1. Course Coverage

Assessment of learning outcomes for Internal and end semester evaluation. Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

Modules	Title	Teach. Hours	No. of question in Exam						CO	Levels
			CIA-1	CIA-2	CIA-3	Asg	Extra Asg	SEE		
1	Fundamental Concepts & Definitions	10	2	-	-	1	1	2	CO1, CO2	L2,3
2	work & Heat & First Law of Thermodynamics	10	2	-	-	1	1	2	CO3, CO4	L3
3	Second Law of Thermodynamic and Entropy	10	-	2	-	1	1	2	CO5, CO6	L3
4	Availability, Ir-reversibility and General Thermodynamic relations	10	-	2	-	1	1	2	CO7, C08	L3
5	Ideal gases and Real gases	10	-	-	4	1	1	2	CO9, CO10	L3
-	**Total**	50	4	4	4	5	5	10	-	-

2. Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

Modules	Evaluation	Weightage in Marks	CO	Levels
1, 2	CIA Exam – 1	30	CO1, CO2, CO3,Co4	L2,L3,L2,L3
3, 4	CIA Exam – 2	30	CO7, C08, CO9, CO10	L2,L3,L2,L3
5	CIA Exam – 3	30	CO5, CO6,	L2,L2
1, 2	Assignment - 1	10	CO1, CO2, CO3,Co4	L2,L2,L2,L2
3, 4	Assignment - 2	10	CO7, C08, CO9, CO10	L2,L2,L2,L3
5	Assignment - 3	10	CO5, CO6,	L2,L3
1, 2	Seminar - 1		-	-
3, 4	Seminar - 2		-	-
5	Seminar - 3		-	-
1, 2	Quiz - 1		-	-
3, 4	Quiz - 2		-	-
5	Quiz - 3		-	-

1 - 5	Other Activities – Mini Project	-	CO9, CO10	L2,L3
	Final CIA Marks	**40**	**-**	**-**

D1. TEACHING PLAN - 1

Module - 1

Title:	**Fundamental Concepts & Definitions**	Appr Time:	10 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	The student should be able to:	CO1	L2
1	Understand the thermodynamic systems and properties.	CO1	L2
2	Apply the above concepts to solve engineering problems.	CO2	L3
b	***Course Schedule***	-	-
Class No	**Portion covered per hour**	-	-
1	Thermodynamic definitions	C01	L2
2	Thermodynamic properties	C01	L2
3	Thermodynamic equilibrium;	C01	L2
4	Definition mechanical equilibrium.	C01	L2
5	Zeroth law of thermodynamics.	C01	L2
6	Temperature; concepts, scales,	CO2	L3
7	International fixed points	CO2	L3
8	Measurement of temperature.	CO2	L3
9	Numerical problems.	CO2	L3
10	Numerical problems.		
c	**Application Areas**	**CO**	**Level**
1	Thermodynamics system is a major part in the design field.	CO1	L2
2	Automobile, Locomotives, Ships,Submarines and Aircraft.	CO2	L3
	Review Questions	-	-
1	Distinguish between Macroscopic and Microscopic approach of study.	CO1	L3
2	Intensive and Extensive properties.	CO1	L2
3	Closed, Open and Isolated systems.	CO1	L2
4	What you mean by Thermodynamic equilibrium' of a system.	CO1	L2
5	Intensive and extensive properties.	CO1	L2
6	Define thermodynamic work and heat.	CO2	L2
7	What is meant by displacement work? Explain the same with reference to the quasi — static process.	CO2	L3
8	State Zeroth law of thermodynamics and e,(plain the working of constant volume gas thermometer.	CO2	L3
9	hat is meant by thermodynamic equilibrium? Explain mechanical, chemical and thermal equilibrium.	CO2	L3
10	Distinguish between: I) Intensive and extensive properties. ii) Microscopic and macroscopic point of view	CO1	L2
e	**Experiences**	-	-
1		CO1	L2
2			

Module – 2

Title:	Work and Heat & First Law of Thermodynamics	Appr Time:	10 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	State the first law of thermodynamic system. write an expression for SFE Equation.	CO3	L3
2	Interpret the energy interaction.	CO4	L3
b	***Course Schedule***	-	-
Class No	**Portion covered per hour**	-	-
11	Work Mechanics, definition of work and its limitations	CO3	L3
12	Displacement work	CO3	L3
13	Shaft work; Electrical work.	CO3	L3
14	Heat; definition, units and sign convention.	CO3	L3
15	Numerical problems.	CO3	L3
16	Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes,	CO4	L3
17	Energy, energy as a property, modes of energy	CO4	L3
18	extension of the First law to control volume.	CO4	L3
19	Steady flow energy equation (SFEE).	CO4	L3
20	important applications and Numericals.	CO4	L3
c	**Application Areas**	**CO**	**Level**
-	Power generating plants.	CO3	L3
1	Energy interactions with atmosphere and with the earth surface play a vital role in Remote sensing.	CO4	L3
2			
d	**Review Questions**	-	-
11	Explain Joules experiments	CO3	L3
12	Explain first law of thermodynamic.	CO4	L3
13	With a neat P-V diagram, derive an expression for work done during polytropic process (Pv^n =C)	CO3	L3
14	Derive an expression for the non-flow displacement work done during adiabatic process C given by PV^y= C , where y = Cp/Cv	CO4	L3
15	showthat heat and work are path function and not properties of the system.	CO4	L3
16	A closed system undergoes two processes one after the other — constant pressure process at a pressure of 5 bar from initial volume of 0.03 m3 to 0.09 m3. It is followed by polytropic expansion process according to PV" = C from 0.09 m3 volume to 0.2 m3 final volume. Sketch the two processes on PV diagram and find (I) Final pressure after expansion. (ii) Work done during each process and net work done.	CO3	L3
17	Write the steady flow energy equation for an open system and explain the terms involved in it, and simplify SFEE for the following systems: (i) Steam turbine and (ii) Nozzle.	CO3	L3
e	**Experiences**	-	-
1		CO3	L2
2			

E1. CIA EXAM – 1

a. Model Question Paper - 1

Crs Code:	18ME33	Sem:	III	Marks:	30	Time:	75 minutes
Course:	BASIC THERMODYNAMICS						

-	-	**Note: Answer all questions, each carry equal marks. Module : 1, 2**	**Marks**	**CO**	**Level**
-	-	**Note: Answer any 3 questions, each carry equal marks.**	**Marks**	**CO**	**Level**
1	a	State the Zeroth Law of Thermodynamics. What is Diathermic wall and adiabatic wall?	4	1	L2
	b	Differentiate between the following with suitable examples: 1. Intensive and extensive properties 2. Path and point function	4	1	L2
	c	A point wire is used as a resistance thermometer. The wire resistance was found to be 10 Ω and 16 Ω at ice point and steam point respectively and 30 Ω at sulfur boiling point of 444.6^{0}C. Find the resistance of the wire at 750^{0}C if the resistance varies with the temperature by the relation $R=R_0\ (1+\alpha t+\beta t^2)$.	7	1	L3
		OR			
2	a	Obtain an expression for work done by the isothermal process.	4	2	L2
	b	Define work and heat in terms of thermodynamics. Write two important similarities between them.	4	2	L2
	c	A cylinder contains 1 kg of a certain fluid at an initial pressure of 20 bar. The fluid is allowed to expand reversibly behind a piston according to law PV^2= constant until the volume is doubled. The fluid is then cooled reversibly at constant pressure until the piston regains its original position. Heat is then supplied reversibly with the piston firmly locked in position until the pressure rises to the original value of 20 bar. Calculate the net work done by the fluid for an initial volume of 0.5m^3	7	2	L3
		MODULE-2			
3	a	A cinema hall of 1000 m^3volume has a capacity to accommodate 80 persons. Each person occupies 0.075 $m^3$of space and has an average heat transfer rate of 600kJ/hr. On a house full day if the air conditioning system fails find the increase in internal energy and temperature of the air in the hall during first 15 minutes of failure. Assume that the hall is well insulated with no heat flow from outside and air in the room comprises the system. If the hall and its contents are considered as a system, what will be the increase in internal energy of the system? Take air is at 27^{0}C and 1 bar.	8	3	L3
	b	Write the steady flow energy equation for an open system and explain the terms involved in it, and simplify SFEE for the following systems: (i) Steam turbine and (ii) Nozzle.	7	3	L2
		OR			
4	a	A Carnot refrigerator is used for removing 6270kJ/min of heat from a cold storage room at -20^{0}C. Heat is discharged to the atmosphere at 25^{0}C. Find the (1) COP of refrigerator (2) Power required	7	4	L3
	b	Give Kelvin-Planck and Clausius statements of second law of thermodynamics and prove that $(COP)_{HP}$=1+COP of refrigerator.	8	4	L2

b. Assignment -1

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions

Crs Code:	18ME33	Sem:	III	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	BASIC THERMODYNAMICS						

Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT16ME057	Define a thermodynamic system. Differentiate between open system and closed system	10	CO1	L2
2	1KT16ME006	Define the following a. Homogeneous and heterogeneous system with example b. Diathermic and Adiabatic Wall	10	CO2	L3
3	1KT17ME10	Show that work is path Function	10	CO2	L3
4	1KT17ME104	A Certain thermometer is calibrated using ice and steam as a fixed points and designating them as 00C and 1000C respectively . The thermodynamic function chosen to establish the scale t=(a ln X+ b), instead of linear scale t=(aX+b). determine the constants „a‟ and „b‟ in terms of X ice and X steam and show that new scale is given by t = 100 ln (□/X ice) /(ln (X staem /X ice))	10	CO1	L3
5	1KT17ME018	A copper block of mass 0.5 Kg at 1000C is placed in a lake of water at 10^0C . Two such blocks at 100^0C & 0^0C respectively are joined together. Take for Copper C=0.393KJ/Kg K	10	CO1	L3
6	1KT17ME019	Estimate the change in entropy of the universe due to each of the following process.	10	CO1	L3
7	1KT17ME020	Derive an expression for Clausius Inequality	10	CO1	L3
8	1KT17ME026	Derive an expression for entropy changes for an open system derive an expression for entropy changes for an open system	10	CO1	L3
9	1KT18ME005	Derive an expression for a closed system undergoing a cycle	10		
10	1KT18ME005	Show that of all heat engine operating between a given constant temperature source and a given constant temperature sink, none has a higher efficiency than a reversible engine.	10	CO2	L3
11	1KT18ME006	Explain the working Principal of Carnot cycle.	10	CO2	L3
12	1KT18ME007	Derive an expression for steady flow energy equation for the controlled Volume.	10	CO2	L3
13	1KT18ME008	Air at 1.02 bar, 220C, initially occupying a cylinder volume of 0.015 m3, is compressed reversibly and adiabatically by a piston to a pressure of 6.8 bar. Calculate i) the final temperature, ii) the final volume, iii) The work done on the mass of air in the cylinder.	10	CO2	L3
14	1KT18ME009	Show that work is path Function	10	CO1	L3
15	1KT18ME011	A closed system undergoes a constant volume process in which 85 kJ of heat is supplied to it. The system then undergoes a constant pressure process in which 90 kJ of heat is rejected by the system and 15 kJ of work is done on it. Finally the system is brought back to its original state by a reversible adiabatic process. Determine i) The magnitude and direction of work transfer during the adiabatic process. ii) The energy of the system at all end states if the energy at the initial state is 100 kJ.	10	CO2	L3
16	1KT18ME012	A mercury manometer is used to measure pressure in a water pipe. If the density of mercury is 13590 kg/m^3 and the manometer height is 300 mm determine the pressure in the pipeline.	10	CO2	L3
17	1KT18ME014	With the aid of appropriate sketches discuss the concept of thermodynamic systems.	10	CO1	L2

18	1KT18ME016	Explain state, path, Process and cycle.	10	CO1	L2
19	1KT18ME017	Write a brief note on reversible process and quasi-static process.	10	CO2	L3
20	1KT18ME018	Explain mechanical, chemical and thermal equilibrium.	10	CO1	L2
21	1KT17ME027	Explain what you understand by thermodynamic equilibrium.	10	CO2	L3
22	1KT17ME028	Distinguish between the terms Change of state, Path and process.	10	CO1	L2
23	1KT17ME029	What is the differences between a closed system and open system.	10	CO2	L3
24	1KT17ME031	An open system defined for ab fixed region and a control volume are synonymous. Explain.	10	CO1	L2
25	1KT17ME032	Why to study Thermodynamic explain with examples	10	CO2	L3
26	1KT17ME034	which of the following processes would it be more appropriate to consider a closed system rather than a control volume? 1)Steady flow discharge of steam from a nozzle 2)Freezing a given mass of water 3)Stirring of air contained in a rigid tank using a mechanical agitator 4)Expansion of air contained in a piston and cylinder device Heating of a metal bar in a furnace Iixing of high pressure and low pressure air initially contained in two separate tanks connected by a pipe and valve.	10	CO3	L2
27	1KT17ME035	Must the boundary of a system be real? Can the boundary of a system be movable?	10	CO2	L3
28	1KT17ME036	Convert 560 F to degree of Rankine, degree of Kelvin, and degree of Centigrade.	10	CO1	L2
29	1KT18ME401	ich of the following are properties of a system: pressure, temperature, density, energy, work, heat, volume, specific heat, and power? List at least three measurable properties of a system.	10	CO2	L3
30	1KT18ME402	a closed system interact mass with its surroundings?	10	CO1	L2
31	1KT18ME403	term ∫Tds is the area under the process on a T-s diagram. How do you interpret this area.	10	CO2	L3
32	1KT18ME404	s a hot system describe a high value of heat, or a high value of temperature of the system?	10	CO2	L2
33	1KT18ME405	An inventor claims to have developed a work-producing closed system cycle which receives 2000 kJ of heat from a heat source and rejects 800 kJ of heat to a heat sink. It produces a net work of 1200 kJ. How do we evaluate his claim?	10	CO2	L3
34	1KT18ME406	m^3 rigid tank contains a quality 0.05745 steam (0.05 m^3 of saturated liquid water and 4.95 m^3 of saturated water vapor) at 0.1 Mpa. Heat is transferred until the pressure reaches 150 kPa. Determine the initial amount of water in the system, final quality of the steam, and heat transfer added to the system.	10	CO2	L2

35	1KT18ME407	kg of helium is compressed in a polytropic process ($pv^{1.3}$=constant). The initial pressure, temperature and volume are 620 kPa, 715.4 K and 0.15 m^3. The final volume is 0.1 m^3. Find (A) the final temperature and pressure, (B) the work done, and (C) the heat interaction.	10	CO2	L3
36	1KT18ME408	at is the boundary work of an open system?	10	CO2	L2
		ich of the following are properties of a system: pressure, temperature, density, energy, work, heat, volume, specific heat, and power? List at least three measurable properties of a system.	10	CO4	L3
		a closed system interact mass with its surroundings?	10	CO3	L2
		term ∫Tds is the area under the process on a T-s diagram. How do you interpret this area.	10	CO3	L3
		s a hot system describe a high value of heat, or a high value of temperature of the system?	10	CO3	L2
		ich of the following are properties of a system: pressure, temperature, density, energy, work, heat, volume, specific heat, and power? List at least three measurable properties of a system.	10	CO4	L3
		a closed system interact mass with its surroundings?	10	CO4	L2
		term ∫Tds is the area under the process on a T-s diagram. How do you interpret this area.	10	CO3	L3
		s a hot system describe a high value of heat, or a high value of temperature of the system?	10	CO4	L3

D2. TEACHING PLAN - 2

Module – 3

Title:	**Second Law of Thermodynamics** and Entropy	Appr Time:	10 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Develop the nature of thermodynamic process.	CO5	L2
2	Illustrate the thermodynamic properties.	CO6	L3
b	***Course Schedule***		
Class No	**Portion covered per hour**	-	-
21	Second Law of Thermodynamics	CO5	L3
22	Devices converting heat to work	CO5	L3
23	Kelvin-Planck statement of the Second law of Thermodynamics;	CO5	L3
24	PMM I and PMM II, Clausius statement of Second law of Thermodynamics.	CO5	L3
25	Equivalence of the two statements; Carnot cycle, Carnot principles omega	CO5	L3
26	Numerical problems.	CO5	L3
27	Entropy: definition Clausius inequality Statement- proof.	CO6	L3
28	Entropy a property, changes of entropy	CO6	L3
29	entropy as a quantitative test for Ir-reversibility	CO6	L3
30	Principle of increase in entropy, entropy as a coordinate	CO6	L3
C	**Application Areas**	CO	Level
1	It is used extensively in the discussion of heat engines.	CO5	L3

2	Thermodynamic properties based applications are refrigerator, the humidifier, the pressure cooker, the water heater.	CO6	L3
d	**Review Questions**	-	-
18	Prove that internal energy is a property	CO5	L3
19	Define Reversibility & factors affecting it.	CO5	L3
20	Explain availability function for closed system (Non flow Process) and open system (Steady Flow process).	CO5	L3
21	Two Carnot engines A and B are connected in series between two reservoirs maintained at 1000K and 300K respectively. Engine A receives 1750 kJ of heat from high temperature reservoir and rejects heat to the Carnot engine B. Engine B takes in heat rejected by engine A and rejects heat to the low temperature reservoir. If Engine A and Engine B have equal thermal efficiencies determine, a) The heat rejected by engine B b) The temperature at which heat rejected by engine A The work done during this process by engines A and B respectively.	CO5	L3
22	Definition of the thermodynamic temperature scale.	CO5	L3
23	write a short notes on a) Principal of increases in entropy & b) Mixing of two fluids	CO6	L3
24	Determine the entropy increase of the universe	CO6	L3
25	state Carnot theorem and explain the working principal of Carnot cycle	CO6	L3
26	A fish refreezing plant requires 40 Tones of refrigeration. The freezing temperature is 300C. If the performance of plant is 20% of the theoretical reversed Carnot cycle working within the same temperature limits, calculate power required. Take 1Ton of refrigerator = 210 kJ/min	CO6	L3
e	**Experiences**	-	-
1			
2			
5			

Module – 4

Title:	**Availability, Ir-reversibility and General Thermodynamic relations**	Appr Time:	10 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Apply the thermodynamic relations.	CO7	L3
2	Interpret the behavior of pure substance.	CO8	L3
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
31	Introduction, Availability (Energy), Unavailable energy, Relation between increase in unavailable energy and increase in entropy.	CO7	L3
32	Maximum work, maximum useful work for a system & control volume	CO7	L3
33	Ir-reversibility, second law efficiency	CO7	L3
34	Numerical problems	CO7	L3
35	Pure Substances: P-T and P-V diagrams, triple point and critical points	CO8	L3
36	Sub-cooled liquid, saturated liquid, mixture of saturated liquid an water ad vapor, saturated vapor and superheated vapor states of pure substance withs example.	CO8	L3
37	Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams.	CO8	L3

38	Steam tables and its use.	CO8	L3
39	Throttling calorimeter, separating and throttling calorimeter.	CO8	L3
40	Numerical problems.	CO8	L3
c	**Application Areas**	**CO**	**Level**
1	Thermodynamic relation are used in thermal power plants.	CO7	L3
2	Air conditioning systems, the refrigerator, the humidifier etc	CO8	L3
d	**Review Questions**	-	-
27	Define a reversible heat engine,	CO7	L3
28	show that of all reversed heat engines working between any two constant but different temperature thermal reservoirs, the reversible reversed heat engine will have the maximum efficiency	CO7	L3
29	Two Carnot engines A and B are connected in series between two reservoirs maintained at 1000K and 300K respectively. Engine A receives 1750 kJ of heat from high temperature reservoir and rejects heat to the Carnot engine B. Engine B takes in heat rejected by engine A and rejects heat to the low temperature reservoir. If Engine A and Engine B have equal thermal efficiencies determine, a) The heat rejected by engine B b) The temperature at which heat rejected by engine A The work done during this process by engines A and B respectively.	CO7	L3
30	With neat sketch explain throttling calorimeter.	CO7	L3
31	Define pure substance and state “Two property rule” & Critical point of water.	CO8	L3
32	Dry saturated steam at 15bar is supplied to an engine in which it expands isentropically to 1.5 bar and then at constant volume to 0.5bar. Calculate the work done during the isentropic expansion and the final condition of the steam.	CO8	L3
33	Explain formation of pure substance.	CO8	L3
34	Explain process involve in pure substance by using P-T and P-V diagrams,	CO8	L3
35	Define triple point and critical points	CO8	L3
36	With neat sketch explain Throttling calorimeter.	CO8	L3
37	Kaplan and Propeller turbines - velocity triangles, design parameters.	CO8	L3
38	A Kaplan turbine develops 9000 kW under a head of 10m. Overall efficiency of the turbineis 85%. The speed ratio based on outer diameter is 2.2 and flow ratio 0.66. Diameter of theboss is 0.4 times the outer diameter of the runner. Determine the diameter of the runner,boss diameter and specific speed of the runner.	CO8	L3
e	**Experiences**	-	-
1		CO7	L2
2			

E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code:	18ME33	Sem:	III	Marks:	30	Time:	75 minutes
Course:	BASIC THERMODYNAMICS						

-	-	Note: Answer all questions, each carry equal marks.	Marks	CO	Level
1	a	Explain how free expansion and friction makes the process irreversible.	7	5	L2
	b	A reversible thermal heat engine operating between two thermal reservoirs at 800^0C and 30^0C respectively. It drives a reversible refrigerator operating between -15^0C and 30^0C. The heat input to the heat engine is 1900 kJ and the network output from the combined plant (Engine and Refrigerator both) is 290kJ. calculate the heat absorbed by the refrigerant and total heat transferred to 30^0C reservoir.	8	5	L3

		OR			
2	a	Prove that for a system executing a cyclic process, $\oint dq/T \leq 0$ and hence define entropy.	7	6	L2
	b	Water is heated from 25^0C to 90^0C as it flows at a rate of 0.5 Kg/s through a tube that is immersed in a hot bath at 100^0C. Calculate heat transfer, Entropy change for water, oil bath and universe. Assume Cpw and Cpg are 4.2 kJ/KgK.	8	6	L3
3	a	Show that the entropy change of an ideal gas is given by the equation of the form S_2-S_1 = C_p ln (V_2/V_1)+ C_v ln (P_2/P_1).	8	9	L2
	b	A mixture of ideal gases contains 5 kg of N_2 and 8 kg of Co_2. the partial pressure of N_2 in the mixture is 120 KPa. find 1)Mole fraction of N_2 and CO_2 2)Partial pressure of Co_2 3)Molecular weight of mixture.	7	9	L3
		OR			
4	a	Explain the following: 1) Reduced properties 2) Law of corresponding state 3) Gibbs-Dalton law 4) Compressibility factor	8	10	L2
	b	A container of $3m^3$capacity contains 10kg of Co_2 at 27^0C .Estimate the pressure exerted by Co_2 using 1)Perfect gas equation 2)Vander Walls equation	7	10	L3

b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	18ME33	Sem:	III	Marks:	5 / 10	Time:	90 – 120 minutes

Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT16ME057	Define a reversible heat engine,	5	CO7	L2
2	1KT16ME006	show that of all reversed heat engines working between any two constant but different temperature thermal reservoirs, the reversible reversed heat engine will have the maximum efficiency	5	CO8	L3
3	1KT17ME10	Two Carnot engines A and B are connected in series between two reservoirs maintained at 1000K and 300K respectively. Engine A receives 1750 kJ of heat from high temperature reservoir and rejects heat to the Carnot engine B. Engine B takes in heat rejected by engine A and rejects heat to the low temperature reservoir. If Engine A and Engine B have equal thermal efficiencies determine, a) The heat rejected by engine B b) The temperature at which heat rejected by engine A The work done during this process by engines A and B respectively.	5	CO8	L3
4	1KT17ME104	Define pure substance and state “Two property rule” &	5	CO8	L3

		Critical point of water.			
5	1KT17ME018	Dry saturated steam at 15bar is supplied to an engine in which it expands isentropically to 1.5 bar and then at constant volume to 0.5bar. Calculate the work done during the isentropic expansion and the final condition of the steam.	5	CO8	L3
6	1KT17ME019	Explain formation of pure substance.	5	CO8	L3
7	1KT17ME020	Explain process involve in pure substance by using P-T and P-V diagrams.	5	CO8	L3
8	1KT17ME026	Define triple point and critical points	5	CO8	L3
9	1KT18ME005	With neat sketch explain Throttling calorimeter.	5	CO8	L3
10	1KT18ME005	ı the entropy of a closed system ever decrease? v many ways that the entropy of a closed system can be increased?	5	CO5	
11	1KT18ME006	Inventor claims to have developed an adiabatic device that executes a steady state expansion process in which the entropy of the surroundings decreases at 5 kJ/(Ksec). Is this possible? Why or why not?	5	CO7	L3
12	1KT18ME007	at is the increase of entropy principle?	5	CO8	L3
13	1KT18ME008	ıniverse an isolated system? What is the surroundings of the universe? en will the entropy value of the universe attained its maximum value?	5	CO8	L3
14	1KT18ME009	at are available and unavailable energy?	5	CO7	L3
15	1KT18ME011	at is minimum temperature value of heat rejection T_L which can be used in real world?	5	CO8	L3
16	1KT18ME012	Write the general mathematical expression of reversible work for a closed system undergoing a change of state 1-2.	5	CO8	L3
17	1KT18ME014	ɘs reversible work of a closed system depend on the surroundings of the system?	5	CO7	L3
18	1KT18ME016	d the specific reversible work developed when air expands in a piston-cylinder assembly from an initial state of 500 kPa and 500 K to a final state of 200 kPa. Neglect changes in potential and kinetic energies, and assume the environment temperature is at 300 K	5	CO8	L3
19	1KT18ME017	ɘs the expression for irreversibility for a closed system different from that of an open system?	5	CO8	L3
20	1KT18ME018	air stream at 150ºC and 400 kPa with mass flow rate of 0.6 kg/s enters a steady-state steady-flow turbine. The stream leaves the turbine at 60ºC and 100 kPa.The turbine delivers a power of 45 kW. Determine the rate of the heat transfer and the rate of irreversibility of the process. The environment temperature is at 283 K	5	CO7	L3
21	1KT17ME027	xergy a state property? Is exergy a variable at a specified state?	5	CO8	L3
22	1KT17ME028	ɘs exergy of a system change when the state of the system changes?	5	CO8	L3

23	1KT17ME029	es energy of an infinitely large heat reservoir change? Why?	5	CO7	L3
24	1KT17ME031	es exergy of an infinitely large heat reservoir change? Why?	5	CO8	L3
25	1KT17ME032	es exergy of a finitely thermal system change? Why? at is a dead state?	5	CO8	L3
26	1KT17ME034	at is the heat interaction of a system at dead state with its surroundings? at is the exergy of a system at equilibrium with its surroundings?	5	CO7	L3
27	1KT17ME035	es exergy represent the amount of work that a real work-producing device delivers?	5	CO8	L3
28	1KT17ME036	es exergy equal to the amount of work that a real work-producing device delivers?	5	CO8	L3
29	1KT18ME401	rgy and entropy are properties of the system alone. Is exergy a property of the system alone?	5	CO7	L3
30	1KT18ME402	es exergy of a system depend on the temperature of the environment?	5	CO8	L3
31	1KT18ME403	the exergy value of a heat source be negative? the exergy value of a heat sink be negative?	5	CO8	L3
32	1KT18ME404	exergy of a heat reservoir different in different environments?	5	CO7	L3
33	1KT18ME405	Consider two geothermal wells whose energy contents are the same. Are the exergies of the two wells the same at different ambient temperature?	5	CO8	L3
34	1KT18ME406	sider a reversible adiabatic process during which no entropy is generated. Does exergy destruction for this process be zero?	5	CO8	L3
35	1KT18ME407	sider an irreversible non-adiabatic process during which no entropy is generated. Does exergy destruction for this process be zero?	5	CO7	L3
36	1KT18ME408	v do you define exergy cycle efficiency of a heat engine?	5	CO8	L3
		he exergy cycle efficiency of a heat pump defined the same as that of a refrigerator?	5	CO8	L3
		v does the exergy cycle efficiency differ from the first law cycle efficiency?	5	CO7	L3
		sider a refrigerator using R-12 as working fluid. It posses an evaporator temperature of 263 K and a condenser temperature of 315 K. The mass flow rate of the refrigerant is 0.01 kg/s. The surroundings temperature is 298 K. Determine the COP. Calculate the second law cycle efficiency and the exergy cycle efficiency of the refrigerator.	5	CO8	L3

D3. TEACHING PLAN - 3

Module – 5

Title:	deal gases and Real gases	Appr Time:	10 Hrs
a	***Course Outcomes***	**CO**	**Blooms**
-	At the end of the topic the student should be able to . . .	-	**Level**
1	Know the nature of gas and properties.	CO9	L3
2	Understand the gas mixtures	CO10	L3
b	***Course Schedule***	-	-
Class No	**Portion covered per hour**	-	-
41	Ideal gas mixtures, Daltons law of partial pressures.	CO9	L3
42	Amagat's law of additive volumes.	CO9	L3
43	Evaluation of properties of perfect and ideal gases.	CO9	L3
44	Air- Water mixtures and related properties.	CO9	L3
45	Numerical problems.	CO9	L3
46	Real gases-introduction, Van-der Wall's equation of state, Van-der Wall's constants in terms of critical properties.	CO10	L3
47	Beattie-Bridgeman equation.	CO10	L3
48	Law of corresponding states, compressibility factor; compressibility chart.	CO10	L3
49	Difference between ideal and real gases.	CO10	L3
50	Numerical problems.	CO10	L3
c	**Application Areas**	-	-
-	Students should be able employ / apply the Module learnings to . . .	-	-
1	Breathing Mechanics Breathing involves pressure differences between the inside of the lungs and the air outside.	CO9, 10	L3
2		CO10	L3
d	**Review Questions**	-	-
-	The attainment of the module learning assessed through following questions	-	-
39	State Dalton"s law of partial pressure & Amagat"s law or Law Leduc"s.	CO9	L3
40	Define the following 1. Reduced properties 2. Compressibility factor	CO9	L3
41	State Wan-der waal's equation.	CO9	L3
43	1kg mol of oxygen undergoes a reversible non-flow isothermal compression and the volume decreases from 0.2 m3 /kg to 0.08 m3 /kg and the initial temperature is 600C. if the gas obeys Vander waal's equation find a. The work done during this process The final pressure	CO9	L3
43	A tank of 0.1m3 capacity contains 1Kg of O2, 0.9Kg of N2, 1.5 Kg of CO2 and 0.1Kg of CO at 300C. Determine a. The total pressure b. Mole fraction of each gas c. Gas constant d. Molecular weight	CO9	L3
44	Evaluate properties of perfect and ideal gases.	CO10	L3
45	Write Beattie-Bridgeman equation.	CO10	L3
46	Law of corresponding states, compressibility factor.	CO10	L3
47	Define (i) Partial pressure (ii) Mole fraction	CO10	L3
48	What is Volume fraction of a gas constituent in a mixture.	CO10	L3
e	**Experiences**	-	-
1		CO10	L2
2		CO9	

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	18ME33	Sem:	III	Marks:	30	Time:	75 minutes
Course:	BASIC THERMODYNAMICS						

-	-	**Note: Answer all questions, each carry equal marks.**	**Marks**	**CO**	**Level**
1	a	What is available energy, Unavailable energy and second law efficiency?	7	7	L2
	b	Obtain an expression for availability of a non flow process.	8	7	L3
		OR			
2	a	Write Maxwell relation,Gibbs and Helmholtz function,explain the terms	7	7	L2
	b	Derive Clausius-Clayperon equation for evaporation of liquid and explain the significance.	8	7	L3
3	a	With phase equilibrium diagram explain P-T diagram for a pure substance? Define tripple point and critical point.	7	8	L2
	b	Vessel of 0.04 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250^0C the mass of liquid present is 9 Kg.Find a)Pressure b)Mass of vapour c)Specific volume d)Enthalpy e) Entropy f) Internal energy.	8	8	L3
		OR			
4	a	Explain with neat sktech a combined seperating and throttling calorimeter?	7	8	L2
	b	Steam is throttled from a pressure of 15bar to 1.5bar, if steam is dry saturated the end of expression,what is dryness fraction at beginning also calculate change in entropy during throttling.	8	8	L3

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	17ME33	Sem:	III	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	BASIC THERMODYNAMICS						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT16ME057	State Dalton"s law of partial pressure & Amagat"s law or Law Leduc"s.	10	CO9	L2
2	1KT16ME006	State Wan-der waal's equation.	10	CO10	L2
3	1KT17ME10	Define the following 1. Reduced properties 2. Compressibility factor	10	CO9	L2

4	1KT17ME104	1kg mol of oxygen undergoes a reversible non-flow isothermal compression and the volume decreases from 0.2 m3 /kg to 0.08 m3 /kg and the initial temperature is 600C. if the gas obeys Vander waal's equation find a. The work done during this process The final pressure	10	CO9	L2
5	1KT17ME018	A tank of 0.1m3 capacity contains 1Kg of O2, 0.9Kg of N2, 1.5 Kg of CO2 and 0.1Kg of CO at 300C. Determine a. The total pressure b. Mole fraction of each gas c. Gas constant d. Molecular weight	10	CO9	L3
6	1KT17ME019	Write a brief note on: (i) Reduced properties. (ii) Law of corresponding states.	10	CO10	L2
7	1KT17ME020	Define as applied to ideal gas mixtures: (i) Mole fraction (ii) Dalton's law of partial pressures. (iii) Relative humidity.(iv) Due point temperature.	10	CO10	L2
8	1KT17ME026	Find the gas constant and apparent molar mass of a mixture of a mixture of 2 kg 0_2 and 3 kg $N_{2,}$ given that universal gas constant is 8314.3 J/kgmoleK. Molar masses of O_2 and N_2 are respectively.32 and 28.	10	CO9	L2
9	1KT18ME005	State Dalton‟s law of partial pressure & Amagat‟s law or Law Leduc‟s.	10	CO10	L2
10	1KT18ME005	State Wan-der waal's equation.	10	CO9	L3
11	1KT18ME006	Define the following 1. Reduced properties 2. Compressibility factor	10	CO10	L2
12	1KT18ME007	1kg mol of oxygen undergoes a reversible non-flow isothermal compression and the volume decreases from 0.2 m3 /kg to 0.08 m3 /kg and the initial temperature is 600C. if the gas obeys Vander waal's equation find a. The work done during this process The final pressure	10	CO9	L3
13	1KT18ME008	A tank of 0.1m3 capacity contains 1Kg of O2, 0.9Kg of N2, 1.5 Kg of CO2 and 0.1Kg of CO at 300C. Determine a. The total pressure b. Mole fraction of each gas c. Gas constant d. Molecular weight	10	CO9	L3
14	1KT18ME009	Write a brief note on: (i) Reduced properties. (ii) Law of corresponding states.	10	CO9	L2
15	1KT18ME011	Define as applied to ideal gas mixtures: (i) Mole fraction (ii) Dalton's law of partial pressures. (iii) Relative humidity.(iv) Due point temperature.	10	CO10	L3
16	1KT18ME012	Find the gas constant and apparent molar mass of a mixture of a mixture of 2 kg 0_2 and 3 kg $N_{2,}$ given that universal gas constant is 8314.3 J/kgmoleK. Molar masses of O_2 and N_2 are respectively.32 and 28.	10	CO9	L2
17	1KT18ME014	State Dalton‟s law of partial pressure & Amagat‟s law or Law Leduc‟s.	10	CO9	L2
18	1KT18ME016	State Wan-der waal's equation.	10	CO9	L2
19	1KT18ME017	Define the following 1. Reduced properties 2. Compressibility factor	10	CO10	L2
20	1KT18ME018	1kg mol of oxygen undergoes a reversible non-flow isothermal compression and the volume decreases from 0.2 m3 /kg to 0.08 m3 /kg and the initial temperature is 600C. if the gas obeys Vander waal's equation find a. The work done during this process The final pressure	10	CO10	L2

21	1KT18ME019	A tank of 0.1m3 capacity contains 1Kg of O2, 0.9Kg of N2, 1.5 Kg of CO2 and 0.1Kg of CO at 300C. Determine a. The total pressure b. Mole fraction of each gas c. Gas constant d. Molecular weight	10	CO10	L2
22	1KT18ME005	Write a brief note on: (i) Reduced properties. (ii) Law of corresponding states.	10	CO10	L2
23	1KT18ME005	Define as applied to ideal gas mixtures: (i) Mole fraction (ii) Dalton's law of partial pressures. (iii) Relative humidity.(iv) Due point temperature.	10	CO9	L3
24	1KT18ME005	Find the gas constant and apparent molar mass of a mixture of a mixture of 2 kg 0_2 and 3 kg $N_{2,}$ given that universal gas constant is 8314.3 J/kgmoleK. Molar masses of O_2 and N_2 are respectively.32 and 28.	10	CO10	L2
25	1KT17ME032	State Dalton‟s law of partial pressure & Amagat‟s law or Law Leduc‟s.	10	CO9	L2
26	1KT17ME034	State Wan-der waal’s equation.	10	CO9	L2
27	1KT17ME035	Define the following 1. Reduced properties 2. Compressibility factor	10	CO9	L3
28	1KT17ME036	1kg mol of oxygen undergoes a reversible non-flow isothermal compression and the volume decreases from 0.2 m3 /kg to 0.08 m3 /kg and the initial temperature is 600C. if the gas obeys Vander waal’s equation find a. The work done during this process The final pressure	10	CO10	L2
29	1KT18ME401	A tank of 0.1m3 capacity contains 1Kg of O2, 0.9Kg of N2, 1.5 Kg of CO2 and 0.1Kg of CO at 300C. Determine a. The total pressure b. Mole fraction of each gas c. Gas constant d. Molecular weight	10	CO10	L2
30	1KT18ME402	Write a brief note on: (i) Reduced properties. (ii) Law of corresponding states.	10	CO9	L2
31	1KT18ME403	Define as applied to ideal gas mixtures: (i) Mole fraction (ii) Dalton's law of partial pressures. (iii) Relative humidity.(iv) Due point temperature.	10	CO10	L2
32	1KT18ME404	Find the gas constant and apparent molar mass of a mixture of a mixture of 2 kg 0_2 and 3 kg $N_{2,}$ given that universal gas constant is 8314.3 J/kgmoleK. Molar masses of O_2 and N_2 are respectively.32 and 28.	10	CO9	L2
33	1KT18ME405	Write a brief note on: (i) Reduced properties. (ii) Law of corresponding states.	10	CO10	L2
34	1KT18ME406	Define as applied to ideal gas mixtures: (i) Mole fraction (ii) Dalton's law of partial pressures. (iii) Relative humidity.(iv) Due point temperature.	10	CO9	L2
35	1KT18ME407	Find the gas constant and apparent molar mass of a mixture of a mixture of 2 kg 0_2 and 3 kg $N_{2,}$ given that universal gas constant is 8314.3 J/kgmoleK. Molar masses of O_2 and N_2 are respectively.32 and 28.	10	CO9	L2
36	1KT18ME408		10	CO9	L2

F. EXAM PREPARATION

1. University Model Question Paper

Course:	BASIC THERMODYNAMICS					Month / Year		01/01/20
Crs Code:	18ME33	Sem:	III	Marks:	100	Time:		180 minutes

Module	Note	Answer all FIVE full questions. All questions carry equal marks.	Marks	CO	
1	a	State Zeroth law of thermodynamics? Write its importance in (08Marks) thermodynamics.	8	CO1	L3
	b	A Temperature T on a thermometric scale is defined as T=a ln K + b where a and b are the constants. the value of K found to be 1.83 and 6.78 at 0 0 C and 100 0 C respectively . Calculate temp the temperature for the of K=2.42.	8	CO2	L3
		OR			
-	a	Write the corollaries of first law thermodynamics	8	CO1	L3
	b	Air at 1.02 bar, 220C, initially occupying a cylinder volume of 0.015 m3, is compressed reversibly and adiabatically by a piston to a pressure of 6.8 bar. Calculate i) the final temperature, ii) the final volume, iii) The work done on the mass of air in the cylinder.	8	CO2	L3
2	a	Derive an expression for Pdv work for the following Qausitastic process. a) Constant Volume Process b) Constant Pressure Process c) Isothermal process d) Polytrophic process	8	C03	L3
	b	Compute the work done by 1 kg of a fluid system as it expands slowly behind a system from an initial pressure of 6x10 5 Pa & initial volume of 0.06m 3 & final volume of 0.18 in the following processes. (i) pressure remains constants (ii) volume remains constants (iii) PV 1.3 =C	8	CO4	L3
		OR			
-	a	Prove that COP Heat Pump = 1+COP refrigerator	8	CO3	L3
	b	A copper block of mass 0.5 Kg at 1000C is placed in a lake of water at 100C . Two such blocks at 1000C & 00C respectively are joined together. Take for Copper C=0.393KJ/Kg K	8	CO4	L3
3	a	Explain the various reasons of irreversibility.	8	CO5	L3
	b	A household refrigerator is maintained at a temperature of 2 0 C. Every time the door is opened, warm material placed inside, introducing an average of 420 kJ, but making only a small change in temperature of the refrigerator. The door is opened 20 times a day, and the refrigerator operates at 15% of the ideal COP. The cost of work is Rs.250 per kWh. What is the monthly bill for this refrigerator? The atmospheric is at 30 ^{0} C.	8	CO6	L3

		OR			
-	a	State and prove Clausius theorem	8	CO5	L3
	b	A limp of steel weighting 30 Kg at a temperature of 427 0 C is dropped in 150Kg of oil at 27 0 C . the specific heat of steel and oil are 0.5 kJ/Kg K and 2.5 kJ/Kg K respectively. Estimate the change in entropy of steel , the oil and the system consisting of oil and lump of steel.	8	CO6	L3
4	a	Define the following a) available energy b) unavailable energy & c) availability	8	CO7	L3
	b	write a short note on Clapeyron equation and Joules- Thomson effect	8	CO8	L3
		OR			
	a	Draw the following diagrams for water and various pressure and name the different regions and states: i) Pressure-temperature diagrams ii) Temperature –volume diagram	8	CO7	L3
	b	Steam at 10bar and 0.95 dry flows at 130m/sec in a pipe. It is throttled to 8bar and the flow rate is 12kg/sec. Assuming velocity in the pipe on the downstream side of the valve is 160m/sec. Find the final condition of team and the pipe diameters before and after the valve.	8	CO8	L3
5	a	Explain the following law a) Dalton‟s law of partial pressure: b) Amagat‟s law or Law Leduc‟s:	8	CO9	L3
	b	A mixture of the gases has the following volumetric composition CO 2 =12%,O 2 =4%,N 2 =82%,CO=2% Calculate a. The gravimetric composition b)Molecular weight of the mixture R for the gas mixture	8	CO10	L3
		OR			
-	a	Define the following a) Reduced Properties b) Corresponding State c) Compressibility Factor	8	CO9	L3
	b	1kg mol of oxygen undergoes a reversible non-flow isothermal compression and the volume decreases from 0.2 m 3 /kg to 0.08 m 3 /kg and the initial temperature is 60 0 C. if the gas obeys Vander waal's equation find a. The work done during this process b. The final pressure	8	CO10	L3

2. SEE Important Questions

Course:	BASIC THERMODYNAMICS					Month / Year	May /2018
Crs Code:	18ME33	Sem:	III	Marks:	100	Time:	180 minutes

	Note	Answer all FIVE full questions. All questions carry equal marks.	-	-	
Module	Q no.	Important Question	**Marks**	**CO**	**Year**
1	a	Distinguish between the followings with example: i) Macroscopic and microscopic view point. ii) Thermodynamic system and control volume. iii) Extensive and intensive property. iv) Thermal equilibrium and thermodynamic equilibrium.	16 / 20	CO1	2017/ 18
	b	The temperature 't' on a linear Celcius scale is related to thermometric property 'X' by the relation, t = A. loge X + B, where A and B are constants. The value of X was found to be 1.47 and 5.2 at the ice point and steam point which are assigned the numbers 0 and 100 respectively on Celcius scale. Determine the temperature 't' corresponding to a reading of X equal to 2.65.		CO1	2017
	c	State and prove Clausius inequality.		CO2	2016
		Show that entropy of an isolated system either increases or in the limit remains constant.		CO2	2016
2	a	Distinguish between heat and work in thermodynamics.	16 / 20	CO3	2016
	b	A spherical balloon has an initial diameter of 25cm and contains air at 1.2 bar. Because of heating the diameter of the balloon increases to 30cm and during the heating process the pressure is found to be proportional to the diameter. Calculate the work done during the process.		CO3	2015
	c	A gas contained in a cylinder fitted with a piston loaded with a small number of weights is at 1.3 bar pressure and 0.03m3 volume. The gas is heated until the volume increases to 0.1m3. Calculate the work done by the gas in the following processes: i) Pressure remains constant; ii) Temperature remains constant; iii) PV1.3 = C during the process. Show the processes on P-V diagram.		CO4	2009
	d	Show that work and heat are path functions.		CO4	2016
		To a closed system 150 kJ of work is done on it. If the initial volume is 0.6 m3 and pressure of system varies as follows: P = (8 — 4V), where 'P' is pressure in bar and `V' is volume in m3 . Determine the final volume and pressure of the system.		CO4	2016
3	a	With the help of Joules experiment, explain the first law of thermodynamic system. Also state its limitation.	16 / 20	CO5	2016
	b	Show that energy is a property of the system.		CO5	2016
	c	Write down the energy equation for flow processes and reduce the same for the followings with significance: i) Steady flow energy equation ii) Nozzle iii) Throttling device		CO6	2018

		iv) Compressor v) Filling of an evacuated tank.			
		State and explain the first law of thermodynamics. Give its equation with reference to a cyclic and non cyclic process.		CO6	2015
4	a	Draw phase equilibrium diagram for water on P-V coordinates and indicate relevant parameters on it.	16 / 20	CO7	2015
	b	Define available and unavailable energy.		CO7	2016
	c	For a non-flow system, show that the heat transferred is equal to the change in enthalpy of a system.		CO8	2017
	d	Draw phase equilibrium diagram for water on P-V coordinates and indicate relevant parameters on it.		CO8	2018
5	a	give the statement of, (i) Dalton's law of additive pressures (ii) Amagat's law of volume additives.	16 / 20	CO9	2009
	b	Write down the Vander Vas " equation of state. How it differs from ideal gas equation .		CO9	2017
	c	Write a brief note on: (i) Reduced properties. (ii) Law of corresponding states.		CO10	2018
	d	Find the gas constant and apparent molar mass of a mixture of a mixture of 2 kg 0_2 and 3 kg $N_{2,}$ given that universal gas constant is 8314.3 J/kgmoleK. Molar masses of O_2 and N_2 are respectively.32 and 28.		CO10	2018

G. Content to Course Outcomes

1. TLPA Parameters

Table 1: TLPA – Example Course

Module- #	Course Content or Syllabus (Split module content into 2 parts which have similar concepts)	Content Teaching Hours	Blooms' Learning Levels for Content	Final Blooms' Level	Identified Action Verbs for Learning	Instruction Methods for Learning	Assessment Methods to Measure Learning
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*
1	**Fundamental Concepts & Definitions:** Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; Definition and units, intensive, extensive properties, specific properties, pressure, specific volume. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes.	4	- L1 - L2	L2	Understand	- Lecture - -	- Assignment - -
1	Zeroth law of thermodynamics. Temperature; concepts, scales, international fixed points and Measurement of temperature. Constant volume gas Thermometer, constant pressure gas thermometer, mercury in glass thermometer	6	- L2 - L2	L2	Understand	- Lecture - -	- Assignment - -

	& Numerical problems.						
2	**Work and Heat:** Mechanics, definition of work and its limitations. Thermodynamic definition of work; Examples, sign Convention. Displacement work; as a part of a system boundary, as a whole of a system boundary. Expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention. Numerical problems.	4	- L2 - L2	L2	Understan d	- Lecture -	- Assignment -
2	**First Law of Thermodynamics:** Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy Extension of the First law to control volume; steady flow energy equation (SFEE), important applications.	6	- L2 - L2	L2	Understan d	- Lecture -	- Assignment -
3	.**Second Law of Thermodynamics:** Limitations of first law of thermodynamics Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir, Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficients of performance. Kelvin-Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics. Equivalence of the two statements; Carnot cycle, Carnot principles. Numerical problems.	4	- L2 - L2	L2	Understan d	- Lecture -	- Assignment -
3	**Entropy:** Clausius inequality, Statement-proof. Entropy- definition, a property, changes of entropy, entropy as a quantitative test for irreversibility. Principle of increase in entropy, entropy as a coordinate. Numerical problem	6	- L2 - L2	L2	Understan d	- Lecture - -	- Assignment - -
4	**Availability, Ir-reversibility and General Thermodynamic relations:** Introduction, Availability (Energy), Unavailable energy, Relation between increase in unavailable energy and increase in entropy. Maximum work, maximum useful work for a system	5	- L2 - L2	L2	Understan d	- Lecture - -	- Assignment - -

	& control volume, Ir-reversibility, second law efficiency. Numerical problems.						
4	**Pure Substances:** P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid an water ad vapor, saturated vapor and superheated vapor states of pure substance withs example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables and its use. Throttling calorimeter, separating and throttling calorimeter. Numerical problems	5	- L2 - L2	L2	Understan d	- Lecture - -	- Assignment - -
5	**deal gases:** Ideal gas mixtures, Daltons law of partial pressures. Amagat's law of additive volumes. Evaluation of properties of perfect and ideal gases. Air- Water mixtures and related properties. Numerical problems.	5	- L2 - L2	L2	Understan d	- Lecture - -	- Assignment - -
5	**Real gases-**introduction, Van-der Wall's equation of state, Van-der Wall's constants in terms of critical properties. Beattie-Bridgeman equation. Law of corresponding states, compressibility factor; compressibility chart. Difference between ideal and real gases and Numerical problems.	5	- L2 - L2	L2	Understan d	- Lecture - -	- Assignment - -

2. Concepts and Outcomes:

Table 2: Concept to Outcome – Example Course

Mo dul e- #	Learning or Outcome from study of the Content or Syllabus	Identified Concepts from Content	Final Concept	Concept Justification (What all Learning Happened from the study of Content / Syllabus. A short word for learning or outcome)	CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology, 4.Benchmark)	Course Outcome **Student Should be able to ...**
A	*I*	*J*	*K*	*L*	*M*	*N*
1	thermodyna mic systems and properties.	Thermod ynamic system and Temperat ure Scales	Thermodyna mic system	Analyze system	Understanding apply Understanding apply	Analyze system
1	Apply the above concepts engineering	Conserva tion of energy and	Energy conversion	Analyze the problems	Understanding apply	Analyze property

	problems.	Energy interaction				
2	State the first law of thermodynamic system. write an expression for SFE Equation.	Nature of thermodynamic processes and Thermodynamic system properties	Conservation of energy	Apply SFEE	Understanding apply	Apply sfee to any system
2	Interpret the energy interaction.	Thermodynamic relations and Properties of substance	Energy interaction	Analyze Interaction of Energy	Understanding apply	Analyze energy interaction-system
3	Develop the nature of thermodynamic process.	Ideal gas properties and Real gas properties	Nature of thermodynamic processes	Analyze process	Understanding apply	Analyze system process
3	Illustrate the thermodynamic properties.	Thermodynamic system properties	Thermodynamic system properties	Analyze the process		Analyze system property
4	Apply the thermodynamic relations.	Thermodynamic relations	Thermodynamic relations	Analyze td relations		Analyze system relation process
4	Interpret the behavior of pure substance.	Properties of substance	Properties of substance	Analyze pure substance	Understanding apply	Analyze pure substance
5	Calculate thermodynamic properties of real gases at all ranges of pressure and temperature.	Ideal gas properties	Ideal gas properties	Ranges of pressure and temperature	Understanding apply	Analyze system ideal gas
5	Calculate the thermodynamic properties of real gases at	Real gas properties	Real gas properties	Analyze gases as ideal and real	Understanding apply	Analyze td relations

	all ranges of pressure and temperature using modified equation.					