Buddha Institute of Technology			
Department: Mechanical Engineering			
Academic Semester: July – Dec 2022			
Semester: 3rd	Section: A	Course Code: KME301	Course: Thermodynamics
Course Instructor: Mr. Ved Prakash Pandey		Contact Hours /week: 6(5+1)	# of credits: 04
CIE Marks: 30		SEE Marks:70	Exam Hours: 03

Prerequisites if any:

Code No	Course Name	Description	Semester
NOT APPLICABLE			

Content delivery:	Chalk & Board, DLP, System/Laptop with social media videos

COURSE SYLLABUS:

Module No	Contents of Module	Hrs	COs

1	**Review of Fundamental Concepts and Definitions:** Introduction- Basic Concepts: System, Control Volume, Surrounding, Boundaries, Universe, Types of Systems, Macroscopic and Microscopic view points, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Exact & Inexact Differentials, Cycle Reversibility Quasi – static Process, Irreversible Process, Causes of Irreversibility Energy and its forms, Work and heat (sign convention), Gas laws, Ideal gas, Real gas, Law of corresponding states, Property of mixture of gases, electrical, magnetic, gravitational, spring and shaft work. **Zeroth law of thermodynamics:** Concept of Temperature and its' measurement, Temperature scales. **First law of thermodynamics:** First Law for Flow Processes - Derivation of general energy equation for a control volume;Steady state steady flow processes including throttling; Examples of steady flow devices;Unsteady processes; examples of steady and unsteady I law applications for system andcontrol volume. Limitations of first law of thermodynamics, PMM-I. Steady flow systems and their analysis, Steady flow energy equation, Boilers, Condensers, Turbine, Throttling process, Pumps etc.	**16**	**CO1**
2	**Second law of thermodynamics:** Thermal reservoirs, Energy conversion, Heat engines, Efficiency, Reversed heat engine, Heat pump, Refrigerator, Coefficient of Performance, Kelvin Planck and Clausius statement of second law of thermodynamics, Equivalence of the two statements. Reversible and irreversible processes, Carnot cycle and Carnot engine, Carnot theorem and it's corollaries, Thermodynamic Temperature Scale, PMM-II. **Entropy:** Clausius inequality, Concept of Entropy, Entropy change of pure substance in different thermodynamic processes, Tds equation, Principle of entropy increase, T-S diagram, Statement of the third law of thermodynamics.	**10**	**CO2**
3	**Availability and Irreversibility:** Available and unavailable energy, Availability and Irreversibility, Second law efficiency, Helmholtz & Gibb's function. **Thermodynamic relations:** Conditions for exact differentials. Maxwell relations, Clapeyron equation, Joule-Thompson coefficient and Inversion curve. Coefficient of volume expansion, Adiabatic and Isothermal compressibility.	**22**	**CO3**

4	**Properties of steam and Rankine cycle:** Pure substance, Property of Pure Substance (steam), Triple point, Critical point, Saturation states, Subcooled liquid state, Superheated vapour state, Phase transformation process of water, Graphical representation of pressure, volume and temperature, P-T, P-V and P-h diagrams, T-S and H-S diagrams, use of property diagram, Steam-Tables & Moller chart, Dryness factor and it's measurement, processes involving steam in closed and open systems. Simple Rankine cycle. **Air-water vapour mixture and Psychrometry:** Psychometric terms and their definitions, Psychometric chart, Different Psychometric processes and their representation on Psychometric chart.	**13**	**CO4**
5	**Refrigeration Cycles:** Reversed Carnot Cycle for gas and vapour. Refrigeration capacity, unit of refrigeration. Air Refrigeration cycles; Reversed Brayton Cycle and Bell Coleman Cycle. Vapour compression refrigeration cycle; simple saturated cycle and actual vapour compression refrigeration cycle. Analysis of cycles, effect of superheating, sub-cooling and change in evaporator and condenser pressure on performance of vapour compression refrigeration cycle. Refrigerants; their classification and desirable properties. Vapour absorption refrigeration system.	**10**	**CO5**

COURSE OUTCOMES: At the end of the Course, the Student will be able to:

KME301.1	After completing this course, the students will be able to apply energy balance to systems and control volumes, in situations involving heat and work interactions.
KME301.2	Students can evaluate changes in thermodynamic properties of substances.
KME301.3	The students will be able to evaluate the performance of energy conversion devices.
KME301.4	The students will be able to differentiate between high grade and low-grade energies.
KME301.5	Students can evaluate changes in thermodynamic properties of substances.

Mapping of CO v/s PO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
KME301.1	2	1	–	–	–	2	–	–	–	–	–	–
KME301.2	–	1	3	–	–	–	–	–	–	–	–	–
KME301.3	–	–	–	2	–	–	–	–	–	–	–	–
KME301.4	1	2	–	–	–	2	–	–	–	–	–	–
KME301.5	–	2	–	–	–	–	–	–	–	–	–	–

Correlation levels: 1-Slight (Low) 2-Moderate (Medium) 3-Substantial (High)

Mapping of CO v/s PSO:

	PSO1	PSO2
KME301.1	2	2
KME301.2	2	2
KME301.3	2	2
KME301.4	2	2
KME301.5	2	2

Gap in the syllabus	NIL

Topics to be covered beyond syllabus	NIL

Assessment Methodologies:

Sl. No.	Description	Type
1	Student Assignment	Direct
2	Internal assessment	Direct
3	University exam	Direct
4	Student feedback	Indirect
5	Alumni feedback	Indirect
6	Employers feedback	Indirect

LESSON PLAN

Lecture #	Module#	Topics	RBT Levels	Course Outcome Mapping	Planned Date	Actual Date	Faculty Sign	Remarks
1.	**1**	Introduction- Basic Concepts: System, ControlVolume	**L3**	**CO1**	29/8/2022			
2.		Surrounding, Boundaries, Universe, Types of Systems,			30/8/2022			
3.		Macroscopic and Microscopicviewpoints,			31/8/2022			
4.		Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Exact & Inexact Differentials,			01/9/2022			
5.		Cycle Reversibility Quasi – static Process, Irreversible Process, Causes of Irreversibility Energy and its forms			02/9/2022			
		Tutorial			3/9/2022			
6.		Work and heat (sign convention), Gas laws, Ideal gas, Real gas			5/9/2022			
7.		Law of corresponding states, Property of mixture of gases,			6/9/2022			

8.		electrical, magnetic, ,			7/9/2022			
9.		gravitational			8/9/2022			
10.		spring and shaft work.			9/9/2022			
		Tutorial			10/9/2022			
11.		Zeroth law of thermodynamics:Concept of Temperature and its' measurement, Temperature scales.			12/9/2022			
12.		First law of thermodynamics: First Law for Flow Processes - Derivation of general energy equation for a control volume			13/9/2022			
13.		Steady state steady flow processes including throttling;			13/9/2022			
14.		Examples of steady flow devices;Unsteady processes; examples of steady and unsteady I law applications for system andcontrol volume.			13/9/2022			
15.	**2**	Limitations of first law of thermodynamics, PMM-I.	**L2**	**CO2**	13/9/2022			
		Tutorial			14/9/2022			
16.		Steady flow systems and their analysis, Steady flow energy equation,			15/9/2022			
17.		Boilers, Condensers, Turbine, Throttling process, Pumps etc, Throttling process, Pumps etc			16/9/2022			
18.		Thermal reservoirs, Energy conversion,			17/9/2022			

19.		Heat engines, Efficiency, Reversed heat engine			19/9/2022			
20.		Heat pump, Refrigerator, Coefficient of Performance,			20/9/2022			
21.		Tutorial			21/9/2022			
		Kelvin Planck and Clausius statement of second law of thermodynamics,			22/9/2022			
22.		Equivalence of the two statements. Reversible and irreversible processes,			22/9/2022			
23.	**3**	Carnot cycle and Carnot engine, Carnot theorem and it's corollaries,	**L4**	**CO3**	23/9/2022			
24.		Thermodynamic Temperature Scale, PMM-II			24/9/2022			
25.		Clausius inequality,			26/9/2022			
		Tutorial			27/9/2022			
26.		Concept of Entropy, Entropy change of pure substance in different thermodynamic processes,			28/9/2022			
27.		Tds equation, Principle of entropy increase,			29/9/2022			
28.		T-S diagram, Statement of the third law of thermodynamics			30/9/2022			
29.		Available and unavailable energy			1/10/2022			
30.		Availability and Irreversibility			3/10/2022			
		Tutorial			6/10/2022			
31.		Second law efficiency			7/10/2022			
32.		Helmholtz & Gibb's function.			8/10/2022			
33.		Conditions for exact differentials.			10/10/2022			

34.		Maxwell relations,			11/10/2022			
35.		Clapeyron equation,			12/10/2022			
		Tutorial			13/10/2022			
36.		Joule-Thompson coefficient and Inversion curve			14/10/2022			
37.		Coefficient of volume expansion			15/10/2022			
38.		Adiabatic and Isothermal compressibility.			17/10/2022			
39.		Pure substance			18/10/2022			
40.		Property of Pure Substance (steam), Triple point, Critical point			19/10/2022			
		Tutorial			20/10/2022			
41.	**4**	Saturation states, Subcooled liquid state, Superheated vapour state	**L5**	**CO4**	21/10/2022			
42.		Phase transformation process of water, Graphical representation of pressure, volume and temperature			22/10/2022			
43.		P-T, P-V and P-h diagrams, T-S and H-S diagrams, use of property diagram,			27/10/2022			
44.		Steam-Tables &Moller chart, Dryness factor and it's measurement,			28/10/2022			
45.		processes involving steam in closed and open systems.			29/10/2022			
		Tutorial			31/10/2022			
46.		Simple Rankine cycle.			1/11/2022			

47.	**5**	Psychometric terms and their definitions	**L6**	**CO5**	2/11/2022			
		Psychometric chart						
48.		Different Psychometric processes and their representation on Psychometric chart.			**3/11/2022**			
49.		Reversed Carnot Cycle for gas and vapour			**4/11/2022**			
50.		Tutorial			**7/11/2022**			
		Refrigeration capacity,			**8/11/2022**			
51.		unit of refrigeration			**14/11/2022**			
52.		Air Refrigeration cycles;			**15/11/2022**			
53.		Reversed Brayton Cycle and Bell Coleman Cycle			**16/11/2022**			
54.		Reversed Brayton Cycle and Bell Coleman Cycle			**17/11/2022**			
55.		Tutorial			**18/11/2022**			
56.		Reversed Brayton Cycle and Bell Coleman Cycle			**19/11/2022**			
57.		Vapour compression refrigeration cycle			**21/11/2022**			
58.		Vapour compression refrigeration cycle			**22/11/2022**			
59.		Vapour compression refrigeration cycle			**23/11/2022**			
60.		simple saturated cycle and actual vapour compression refrigeration cycle			**24/11/2022**			
61.		Tutorial			**25/11/2022**			
62.		simple saturated cycle and actual vapour compression refrigeration cycle			**26/11/2022**			

63.		Analysis of cycles, effect of superheating, sub-cooling and change in evaporator and condenser pressure on performance of vapour compression refrigeration cycle			**18/11/2022**			
64.		Analysis of cycles, effect of superheating, sub-cooling and change in evaporator and condenser pressure on performance of vapour compression refrigeration cycle			**01/12/2022**			
65.		Analysis of cycles, effect of superheating, sub-cooling and change in evaporator and condenser pressure on performance of vapour compression refrigeration cycle			**02/12/2022**			
66.		Analysis of cycles, effect of superheating, sub-cooling and change in evaporator and condenser pressure on performance of vapour compression refrigeration cycle			**03/12/2022**			
67.		Analysis of cycles, effect of superheating, sub-cooling and change in evaporator and condenser pressure on performance of vapour compression refrigeration cycle			**10/12/2022**			
68.		Tutorial			**12/12/2022**			
69.		Refrigerants;			**13/12/2022**			
70.		their classification and desirable properties.			**14/12/2022**			
71.		their classification and desirable properties.			**15/12/2022**			

72.		Vapour absorption refrigeration system			**19/12/2022**			
73.		Vapour absorption refrigeration system			**20/12/2022**			
74.		REVISION			**21/12/2022**			

***L1 – Remembering; L2 – Understanding; L3 – Applying; L4 – Analysing; L5 – Evaluating; L6 - Creating**

Literature:

Books and References:

1. Basic and Applied Thermodynamics by PK Nag, MCGRAW HILL INDIA.
2. Thermodynamics for Engineers by Kroos& Potter, Cengage Learning.
3. Thermodynamics by Shavit and Gutfinger, CRC Press.
4. Thermodynamics- An Engineering Approach by Cengel, MCGRAW HILL INDIA.
5. Basic Engineering Thermodynamics, Joel, Pearson.
6. Fundamentals of Engineering Thermodynamics by Rathakrishnan, PHI.
7. Engineering Thermodynamics by Dhar, Elsevier.
8. Engineering Thermodynamics by Onkar Singh, New Age International.
9. Engineering Thermodynamics by CP Arora.
10. Engineering Thermodynamics by Rogers, Pearson.
11. Fundamentals of Engineering Thermodynamics by Moran, Shapiro, Boettner, & Bailey, John Wiley.
12. Engineering Thermodynamics by Mishra, Cengage Learning.
13. Refrigeration and Air Conditioning by C P Arora, MCGRAW HILL INDIA. **Sample Questions:**

Assessment rubrics that is going to be adopted for direct attainment is depicted in below table

Level of Achievement	Elaboration on Course Grading Description	Bench Mark Set (Out of 25)
Excellent (A)	The Student's performance is outstanding in almost all the intended course learning outcomes	21 to 25
Good (B)	The student's performance is good in most of the intended course learning outcomes.	15 to 20
Marginal (C)	The student's performance is barely satisfactory. It marginally meets the intended course learning outcomes	12 to 14
Fail (F)	The Students performance is inadequate. Student fails to meet many of the intended course learning outcomes	Less than 12