Name of Institute: Indus Institute of Technology and Engineering
Name of Faculty: Dr. Parag Rajpara

Course code: ME0429
Course name: **Engineering Thermodynamics**
Pre-requisites: Basics of Mechanical Engineering
Credit points: 3
Offered Semester: 4th

Course Coordinator (weeks 01 - 12)
Full Name: Dr. Parag Rajpara
Department with sitting location: Automobile Department
Telephone: +91-7383038085
Email: paragrajpara.am@indusuni.ac.in
Consultation times: 03.50 PM – 04:15 PM (Tuesday and Friday)
09.00 AM – 10.00 AM (Working Saturdays)

Course Lecturer (weeks 01 - 12)
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Department with siting location: Automobile Department
Telephone: +91-7383038085
Email: paragrajpara.am@indusuni.ac.in
Consultation times:03.50 PM – 04:15 PM (Tuesday and Friday)
09.00 AM – 10.00 AM (Working Saturdays)

Students will be contacted throughout the Session via Mail with important information relating to this Course.

Course Objectives

1. To study various energy interactions notably heat and work transfer based on certain laws of nature which are never seen to be violated.
2. To develop the idea of thermodynamics and topics like first law of thermodynamics, second law of thermodynamics, concept of entropy, properties of pure substances, gas power cycles, vapour power cycles, refrigeration etc.
3. To evaluate the thermal performance of different heat engines and refrigeration cycles through the calculation of their thermal efficiency or coefficient of performance.

Course Outcomes (CO)

After learning the course the students should be able to

1. Understand basic terms used in thermodynamics.
2. Understand laws of thermodynamics and its applications.
3. Comprehend the concept and applications of energy, entropy and exergy.
4. Understand various gas and vapour power cycles.
5. Understand the properties of gas mixtures

Course Outline

UNIT 1

[12 hours]

CONCEPTS OF THERMODYNAMICS

Microscopic & macroscopic point of view, thermodynamic system and control volume, thermodynamic properties, processes and cycles, Thermodynamic equilibrium, Quasi-static process.

UNIT 2

[12 hours]

FIRST LAW OF THERMODYNAMICS

First law for a closed system undergoing a cycle and change of state, Energy-A property of the system, Different forms of stored energy, Specific Heat at constant Volume and Pressure, Enthalpy, Energy of an Isolated system, Perpetual motion machine of the first kind-PMM1, Control Volume, Steady flow Process, Mass and Energy balance in a simple steady flow Process.

IDEAL GAS MIXTURES

Composition of a gas mixtures, P-v-T behavior of ideal gas mixtures, properties Of ideal gas mixtures, psychometrics of gas-vapor mixtures.

UNIT 3

[12 hours]

SECOND LAW OF THERMODYNAMICS

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, PMM of Second kind, reversibility and irreversibility, Carnot cycle, Carnot theorem, Absolute thermodynamic temperature scale.

ENTROPY

Clausius theorem, property of entropy, inequality of Clausius, entropy change in an irreversible process, principle of increase of entropy, entropy change for non-flow and flow processes, third law of thermodynamics

AVAILABILITY

Available and unavailable energy, availability of a closed system, availability function of a closed system availability of steady flow system, availability function of open system, Energy of a heat input in a cycle, exergy destruction in heat transfer process, irreversibility.

UNIT 4

[10 hours]

THERMODYNAMIC RELATIONSHIPS

Maxwell's equations, T-ds equations, difference in heat capacities, coefficient of Volume expansion and isothermal compressibility, adiabatic compressibility, ratio of specific heat, energy equations, Joule-Kelvin effect, Clausius-Clapeyran equation.

VAPOUR POWER CYCLES

Ideal Rankine cycle, Comparison of Carnot and Rankine Cycle, Effect of operating variable on Rankine Cycle, Reheating of Steam, Simple Steam Power Cycle, Carnot Vapour Power Cycle,.

AIR STANDARD CYCLES

Concept of air standard cycles, Assumptions, Carnot Cycle, Otto Cycle, Diesel Cycle, Dual Cycle, Comparison of Otto, Diesel and Dual cycles, Efficiency of air standard cycle, Mean Effective Pressure, Relative efficiency. Brayton cycle, effect of reheat, regeneration, intercooling and turbine and compressor efficiency on Brayton cycle. (No numerical, for reheat &regenerative).

Method of delivery

1. Chalk and talk
2. PowerPoint Presentations
3. Self-study material

Study time

3 hours Lectures per week

CO-PO Mapping (PO: Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	-	3	2	-	-	-	-	-	-	-
CO2	1	2	-	3	2	-	-	-	-	-	-	-
CO3	1	3	-	2	3	-	-	-	-	-	-	-

1-Lightly Mapped 2- Moderately Mapped 3- Highly Mapped

Blooms Taxonomyand Knowledge retention(For reference)

(Blooms taxonomy has been given for reference)

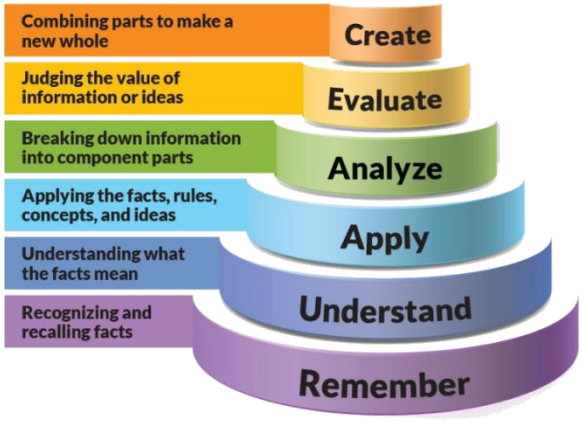

Figure 1: Blooms Taxonomy

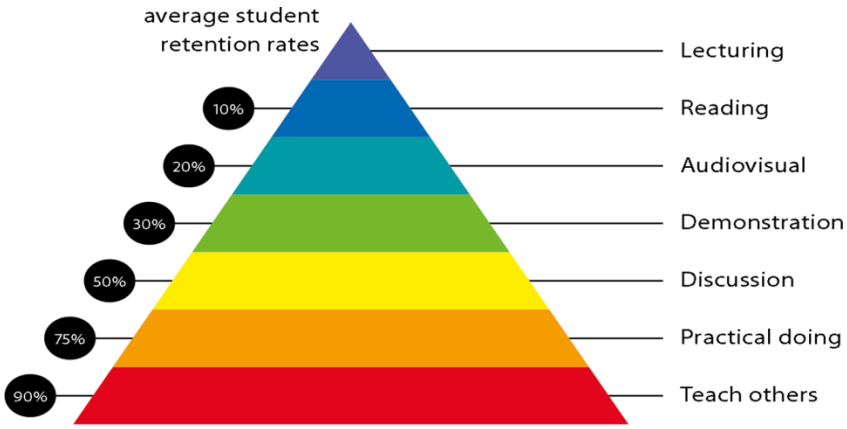

Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Lecture/tutorial times

Lecture/Practical	Timings	Room No.
Lecture 1		**LH-05**
Lecture 2		**LH-05**
Lecture 3		**LH-05**

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

Details of referencing system to be used in written work

1. Text Books and Reference Books
2. Online Resources

Text Books

P.K. Nag, "Engineering Thermodynamics" Tata McGraw-Hill, 5th edition, 2013.

Reference Books

1. R.Yadav, "Fundamentals of Engineering Thermodynamics", Central Publishing House, 3rd edition, 1996.
2. YunusCentel& Boles, "Thermodynamics – An Engineering Approach", Tata McGraw-Hill, 3rd edition, 2013.
3. YVC Rao , "An introduction to Thermodynamics", New Age publishers, 2nd edition, 1993.

Web Resources

1. http://nptel.ac.in/courses/112105123 - Whole syllabus included.
2. https://www.youtube.com/watch?v=ub86Dhg67tM – combustion of fuels
3. https://www.youtube.com/watch?v=RzAPQPWOlNI – Properties of gases and mixtures

MOOC:-

1. https://www.coursera.org/learn/thermodynamics-intro
2. https://onlinecourses.nptel.ac.in/noc18_ae05/preview

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

Theory CIE 60 marks:

a. Attendance 10 Marks
b. Assignments 20 Marks
c. Quiz 1, 2, 3 (Average of best 2) 20 Marks
d Presentation 10 Marks

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in mid semester or end semester will be considered for supplementary assessment in the respective components (i.e mid semester or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (mid semester or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of 10% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment)

Course schedule (subject to change)

Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
Weeks 1	Microscopic & macroscopic point of view, thermodynamic system and control volume	CO1	1. Chalk and talk
Weeks 2	thermodynamic properties, processes and cycles, Thermodynamic equilibrium, Quasi-static process.	CO2	1. Chalk and talk
Week 3	First law for a closed system undergoing a cycle and change of state, Energy-A property of the system, Different forms of stored energy, Specific Heat at constant Volume and Pressure, Enthalpy	*CO2*	1. Chalk and talk 2. PowerPoint Presentations
Week 4	Energy of an Isolated system, Perpetual motion machine of the first kind-PMM1, Control Volume, Steady flow Process, Mass and Energy balance in a simple steady flow Process	CO2	1. Chalk and talk 2. PowerPoint Presentations
Week 5	Composition of a gas mixtures, P-v-T behavior of ideal gas mixtures, properties Of ideal gas mixtures, psychometrics of gas-vapor mixtures.	CO2	1. Chalk and talk
Week 6	Limitations of the First Law – Thermal Reservoir, Heat Engine, Heat pump	CO2	1. Chalk and talk
Week 7	Parameters of performance, Second Law of Thermodynamics, Kelvin-Planck and Clausius Statements and their Equivalence, PMM of Second kind, reversibility and irreversibility	CO3	1. Chalk and talk
Week 8	Carnot cycle, Carnot theorem, Absolute thermodynamic temperature scale. Clausius theorem, property of entropy, inequality of Clausius	CO3	1. Chalk and talk 2. PowerPoint Presentations
Week 9	entropy change in an irreversible process, principle of increase of entropy, entropy change for non-flow and flow processes, third law of thermodynamics	CO3	1. Chalk and talk 2. PowerPoint Presentations
Week 10	Available and unavailable energy, availability of a closed system, availability function of a closed system availability of steady flow system, availability function of open system, Energy of a heat input in a cycle, exergy destruction in heat transfer process, irreversibility.	CO3	1. Chalk and talk 2. PowerPoint Presentations
Week 11	Maxwell's equations, T-ds equations, difference in heat capacities, coefficient of Volume expansion and isothermal	CO3	1. Chalk and talk 2. PowerPoint Presentations

	compressibility, adiabatic compressibility, ratio of specific heat, energy equations, Joule-Kelvin effect, Clausius-Clapeyran equation.		
Week 12	Ideal Rankine cycle, Comparison of Carnot and Rankine Cycle, Effect of operating variable on Rankine Cycle, Reheating of Steam, Simple Steam Power Cycle, Carnot Vapour Power Cycle, Concept of air standard cycles, Assumptions, Carnot Cycle, Otto Cycle, Diesel Cycle, Dual Cycle, Comparison of Otto, Diesel and Dual cycles, Efficiency of air standard cycle, Mean Effective Pressure, Relative efficiency. Brayton cycle, effect of reheat, regeneration, intercooling and turbine and compressor efficiency on Brayton cycle. (No numerical, for reheat &regenerative).	CO3	1. Chalk and talk 2. PowerPoint Presentations