INDIAN INSTITUTE OF TECHNOLOGY KANPUR

ESO 201A: Thermodynamics

Instructor: Dr. Vaibhav Arghode

FIGURE 1–11
A typical match yields about one kJ of energy if completely burned.

A theory is the more impressive the greater the simplicity of its premises, the more different kinds of things it relates, and the more extended its area of applicability. Therefore the deep impression that classical thermodynamics made upon me. It is the only physical theory of universal content which I am convinced will never be overthrown, within the framework of applicability of its basic concepts.

-- Albert Einstein

Lecture: M, W, F: 10.00-10:50 AM in (L19)

Tutorial: Th: 10.00- 10.50 AM (9 class rooms, as indicated below)

Course coordinators:

#	Name	Dept.	E-mail	Tel	Office	Section	Classroom
	Instructor						
	Dr. Vaibhav Arghode	AE	varghode	6294	PL-AE	-	L19
	Tutors						
1	Dr. Sathesh Mariappan	AE	sathesh	6331	NWTF-210A	1	T103
2	Mr. Balasundaram (16101263)	AE	mbala	6910	ACAL-Lab-Old SAC	2	T104
3	Mr. Nitish Arya (15101269)	AE	narya	6843	CPL-NWTF	3	T105
4	Dr. Yogesh Joshi	CHE	joshi	7993	SL-114A	4	T106
5	Dr. Goutam Deo	CHE	goutam	7363	FB-455	5	T107
6	Ms. Shalini Arora (16102278)	CHE	shalini	7895	NL-204	6	T108
7	Dr. Avinash Agarwal	ME	akag	7982	FB-302	7	T109
8	Dr. Jishnu Bhattacharya	ME	jishnu	7684	NL-301	8	T110
9	Dr. Santanu De	ME	sde	6478	NL-302	9	T111

Tutorials, homework problems, lecture slides, exam solutions and course related information will be uploaded in a Google drive. The link of the folder is given below:

https://drive.google.com/drive/folders/1yjuymNAmpD3miNaG_utC1drDNMe2cLZ-?usp=sharing

Grading Policy:

Item	Points	Duration	Remarks
Attendance in lectures	5 points		Biometric
Attendance in tutorials	5 points		Biometric
Two announced quizzes	20 points (10 points for each quiz)	40 minutes for each quiz	Closed book/notes, must bring calculators
Mid-semester examination	30 points	120 minutes	Closed book/notes, must bring calculators
End-semester examination	40 points	180 minutes	Closed book/notes, must bring calculators
Total	**100 points**		

Re-grading: For re-grading please return the mid/end semester examination/quiz copies in the class in which the answer-scripts are distributed, after writing your comments on the top of the answer-scripts. If you are absent (except official leaves, if granted) in that class, you lose the right to appeal. Re-grading requests after you leave the class will not be considered.

Make-up Exams: Only one make-up examination will be given to the students. Mostly, make-up for quiz / mid sem exam will not be entertained. Make-up for the end sem exam will only be considered after approval from DOAA. The entire material covered in the course will be included, irrespective of which test was missed. This make-up will be at the same time as the final make-up exam (date of which will be decided by the DOAA). Thus, there will be only ONE make-up test for the entire course, and it will be taken after the end sem examination.

I-cards: Carrying I-cards is mandatory in all examinations/quizzes.

Mobile phones: Mobile phone should be kept in switched-off mode during the lectures and tutorials and should not be in possession in the exams (mid sem / end sem / quiz).

Tutorials: You must bring calculator, the text book (or property tables given in the appendix of the book) and the tutorial problems in the tutorial class.

Use of unfair means or unethical behavior in the course will lead to harsh punishment.

Text Book: Y. A. Cengel and M. A. Boles, Thermodynamics: An Engineering Approach, 8th Edition, SI Units, Tata McGraw Hill.

	ESO201A: Thermodynamics (2019-2020, first semester)								
	Instructor: Dr. Vaibhav Arghode								
	Semester Plan								
	M	T	W	Th	F	Sa	S		
July	22	23	24	25	26	27	28		
2 lectures	29 (L1)	30	31 (L2)						
August				1 (T1)	2 (L3)	3 (L4X)	4		
14 lectures	5 (L5)	6	7 (L6)	8 (T2)	9 (L7)	10	11		
	12	13	14 (L8)	15	16 (L9)	17 (L10X)	18		
	19 (L11)	20	21 (L12)	22 (T3)	23 (L13)	24	25		
	26 (L14)	27	28 (L15)	29 (T4)	30 (L16)	31 (Q1)			
September							1		
10 lectures	2 (L17)	3	4 (L18)	5 (T5)	6 (L19)	7	8		
	9 (L20)	10	11 (L21)	12 (T6)	13 (L22)	14	15		Lecture (extra class)
	16	17	18	19	20	21	22		Lecture
	23 (L23)	24	25 (L24)	26 (T7)	27 (L25)	28	29		Tutorial
	30 (L26)								Quiz
October		1	2	3 (T8)	4 (L27)	5	6		Mid-Sem Exam
9 lectures	7	8	9	10	11	12	13		End-Sem Exam
	14 (L28)	15	16 (L29)	17 (T9)	18 (L30)	19	20		Make-Up Exam
	21 (L31)	22	23 (L32)	24 (Q2)	25 (L33)	26	27		Mid-Sem Recess
	28 (L34)	29	30 (L35)	31 (T10)					Institute Holiday
November					1 (L36)	2	3		Extra class 1: 3/8 (Sat) 10-11 AM L19
7 lectures	4 (L37)	5	6 (L38)	7 (T11)	8 (L39)	9	10		Extra class 2: 17/8 (Sat) 10-11 AM L19
	11 (L40)	12	13 (L41)	14 (T12)	15 (L42)	16	17		Quiz 1: 31/8 (Sat) 9-10 AM L18, L19, L20
	18	19	20	21	22	23	24		Quiz 2: 24/10 (Th) 10-11 AM L18, L19, L20
	25	26	27	28	29	30			Available tutorial slots: 13
December							1		(tutorials required 12, 1 used for quiz 2)
0 lectures	2	3	4	5	6	7	8		Available lectures slots: 42 (required 39)

Extra class 1: 3/8 (Sat) 10-11 AM L19
Extra class 2: 17/8 (Sat) 10-11 AM L19
Quiz 1: 31/8 (Sat) 9-10 AM L18, L19, L20 OROS
Quiz 2: 24/10 (Th) 10-11 AM L18, L19, L20 OROS
Available tutorial slots: 13 (required 12, 1 used for quiz 2)
Available lectures slots: 42 (required 39)

COURSE OUTLINE

Based on text book: Y. A. Cengel and M. A. Boles, Thermodynamics: An Engineering Approach, 8th Edition, SI Units, Tata McGraw Hill.

- **Chapter 1 (Introduction and Basic Concepts) (2 Lectures)**
  Thermodynamics and Energy; Systems and Control Volumes; Properties of a System; State and Equilibrium; Temperature and Zeroth Law of Thermodynamics

- **Chapter 2 (Energy, Energy Transfer, and General Energy Analysis) (3 Lectures)**
  Forms of Energy; Energy Transfer by Heat, and Work; The First Law of Thermodynamics

- **Chapter 3 (Properties of Pure Substances) (3 Lectures)**
  Phase-Change Processes of Pure Substances; Property Diagrams for Phase-Change Processes; Property Tables; The Ideal-Gas Equation of State; Other Equations of State

- **Chapter 4 (Energy Analysis of Closed Systems) (2 Lectures)**
  Moving Boundary Work; Energy Balance for Closed Systems; Specific Heats, Internal Energy, Enthalpy; Specific Heats of Ideal Gases, Solids and Liquids

- **Chapter 5 (Mass and Energy Analysis of Control Volumes) (3 Lectures)**
  Conservation of Mass; Flow Work and the Energy of a Flowing Fluid; Energy Analysis of Steady-Flow Systems

QUIZ #1 (Syllabus: Chapters 1-5)

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COURSE OUTLINE (contd…)

- **Chapter 6 (The Second law of Thermodynamics) (3 Lectures)**
  Thermal Energy Reservoirs; Heat Engines; Refrigerators and Heat Pumps; Reversible and Irreversible Processes; The Carnot Cycle

- **Chapter 7 (Entropy) (4 Lectures)**
  Entropy, The Increase in Entropy Principle; Entropy Change of Pure Substances; The Tds Relations; Entropy Change of Ideal Gases; Liquids and Solids; Reversible Steady Flow Work; Isentropic Efficiencies of Steady-Flow Devices; Entropy Balance

MID SEMESTER EXAMINATION (Syllabus: Chapters 1-7)

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COURSE OUTLINE (contd…)

- **Chapter 8 (Exergy: A Measure of Work Potential) (3 Lectures)**
  Exergy: Work Potential of Energy; Reversible Work and Irreversibility; Exergy Change of a System; Exergy Transfer by Heat, Work, and Mass; Exergy Destruction, Exergy Balance: Closed Systems and Control Volumes

- **Chapter 9 (Gas Power Cycles) (4 lectures)**
  Air-Standard Assumptions; The Carnot, Otto, Diesel, Stirling, Ericsson, Brayton Cycles; The Brayton Cycle with Regeneration, Intercooling and Reheating

- **Chapter 10 (Vapor and Combined Power Cycles) (3 Lectures)**
  The Carnot Vapor Cycle; Rankine Cycle; The Ideal Reheat and Regenerative Rankine Cycle

QUIZ #2 (Syllabus: Chapters 8-10)

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COURSE OUTLINE (contd…)

- **Chapter 11 (Refrigeration Cycles) (3 Lectures)**
  The Reverse Carnot Cycle; The Ideal Vapor-Compression Refrigeration Cycle; Gas Refrigeration Cycles

- **Chapter 12 (Thermodynamic Property Relations) (3 Lectures)**
  The Maxwell Relations; The Clapeyron Equation; General Relations for du, dh, ds, c_v and c_p; The Joule-Thomson Coefficient

- **Chapter 15 (Chemical Reactions) (3 Lectures)**
  Theoretical and Actual Combustion Processes; Enthalpy of Formation and Enthalpy of Combustion; First-Law Analysis of Reacting Systems; Adiabatic Flame Temperature

END SEMESTER EXAMINATION (Syllabus: Entire Course Content)

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Tentative chapter wise lectures (50 minute duration)

Details	Number of lectures
Chapter 1	2
Chapter 2	3
Chapter 3	3
Chapter 4	2
Chapter 5	3
Quiz I	
Chapter 6	3
Chapter 7	4
Mid Sem	
Chapter 8	3
Chapter 9	4
Chapter 10	3
Quiz 2	
Chapter 11	3
Chapter 12	3
Chapter 15	3
End Sem	
Total lectures	39

Tentative chapter wise tutorials (50 minute duration)

Tutorial 1	Chapter 1
Tutorial 2	Chapter 2
Tutorial 3	Chapter 3 + 4
Tutorial 4	Chapter 5
Quiz 1	
Tutorial 5	Chapter 6
Tutorial 6	Chapter 7
Mid-Sem	
Tutorial 7	Chapter 8
Tutorial 8	Chapter 9
Tutorial 9	Chapter 10
Quiz 2	
Tutorial 10	Chapter 11
Tutorial 11	Chapter 12
Tutorial 12	Chapter 15
End Sem	
Total tutorials	12