Course Title: Thermodynamics

Course Code: FT 308

Resource Person: Rafiq Ahmad

Department: Food Science and Technology

School of Food and Agricultural Sciences (SFAS) Vision

SFAS endeavors to be a premier center of excellence, offering innovative, high-quality education and professional programs aimed at achieving academic and research excellence, enriching the lives of individuals and making a difference in the world of academia and industry, and to develop a society of professionals, who can contribute towards the betterment of their respective communities.

SFAS Mission

SFAS provides an intellectually rich, collaborative, research-focused and dedicated learning environment for students, faculty, and staff, while serving the community at various levels. SFAS at UMT has been established with the aim to integrate recent advances in food sciences/technology and agricultural innovations.

BS Food Science and Technology (Program) Objectives

1. *Explain the basic principles of food sciences, and its multidisciplinary scope.*
2. *Explain the physical, chemical and biological properties of food and their effects on food safety, and sensory and nutritional quality.*
3. *Apply analytical techniques to characterize composition, and to identify physical, chemical and biological changes in foods.*
4. *Explain the effects of food processing, engineering, preservation, packaging, and storage on food safety and quality.*
5. *Identify the importance of food laws and regulations in ensuring safety and quality of the processed/manufactured foods.*
6. *Conduct applied research and use statistical tools in experimental design and data analysis.*
7. *Apply acquired knowledge to real world situations in food systems, components, production, and processes.*
8. *Apply critical thinking to professional problems.*
9. *Communicate effectively in both oral and written forms.*
10. *Develop organizational, teamwork, and leadership skills.*
11. *Demonstrate professional skills and thoughts of ethical, social integrity, and respect for diversity.*
12. *Demonstrate preparedness for continued reflective practice, and lifelong learning relevant to careers in food sciences.*

Course Objectives

At the completion of the course, a student will be able to:

1. *Understand what is Thermodynamics and where do you meet it? What can you solve or calculate with it?*
2. *Define terms and recognize units involved with the basic concepts of heat.*
3. *Perform calculations on problems involving temperature scales, expansion of solids, liquids, and gases, calorimetry, heat transfer by conduction, the gas laws, and the thermodynamic processes.*
4. *Construct pressure versus volume diagrams for the various thermodynamic processes.*
5. *State the first and second law of thermodynamics and apply them to thermodynamic processes.*

Learning Objectives:

Sr#	Course Learning Objectives	Link with Program Learning Objectives
1.	Introduction to Thermodynamics	Student must feel comfortable with the basic reason of studying thermodynamics in BS food science and technology. Where do we meet it and what you can solve with it?
2.	Zeroth law of thermodynamics and concept of temperature. Temperature and pressure scales and measurements.	The temperature, pressure are very important parameters of any engineering process including food processing. Student will be able to explain the effects of food processing, engineering, preservation, packaging, and storage on food safety and quality.
3.	Expansion of solid liquid and gasses	The acquired knowledge will be applied in different food applications, where the expansion upon heating is involved.
3.	Energy, different forms of energy and energy analyses. First law of thermodynamics and concept of energy balance.	Students must be able to understand the different form of energy i.e. kinetic energy, potential energy, work energy (mechanical energy), heat energy, electrical energy, chemical energy and energy transfer from one form to another

		form. The acquired knowledge of will be applied to real world situations in food systems and processes. For example, fluid flow, refrigeration systems, steam generation etc.
4.	Concept of gas laws, kinetic molecular theory, deviation of real gasses from ideal gas behavior. Compressibility factor i.e. a measure of deviation of real gasses from ideal gas behavior.	Introduction to gases and gas laws which explain the relation between pressure, temperature and volume of ideal gas. Kinetic molecular theory of gases, and how kinetic molecular theory explains the behavior of gasses. Derivation of combine gas law from ideal gas laws. The acquired knowledge will be applied in different food engineering and food processes applications.
5.	Properties of pure substance	Student will learn the concept of a pure substance and its phases. How the different thermodynamic properties like pressure, temperature and volume describe the phases of pure substance using the P-V, T-v and P-T property diagrams. The acquired knowledge will be applied to understand the different extraction methods and steam generation used in food applications.
6.	Thermodynamic process and cycles	Thermodynamics process (adiabatic, isothermal process, isochoric process, isobaric process) and how they can be applied in different thermodynamic cycles (I.e. refrigeration cycles).
8.	Heat Transfer	Students will be able to understand the different thermal properties of foods, heat transfer mechanisms. The acquired knowledge of heat transfer will be applied to real world situations in food processes,

		where the heat exchange is happening.
9.	Calorimetry (Heat contents, and heat capacity measurement)	Students will learn the concept of calorimetry which is the measurements of heat and heat capacity. The acquired knowledge of calorimetry will be applied to real world situations in food systems, where they need to determine the heat contents and heat capacity of different foods and vegetables. The acquired knowledge will be applied in heat transfer application for various food processes.

Learning Outcomes

1. *What is thermodynamics and where do we use thermodynamics in food processing.*
2. *Define terms and recognize units involved with the basic concepts of heat.*
3. *Perform calculations on problems involving temperature scales, expansion of solids, liquids, and gases, calorimetry, heat transfer by conduction, the gas laws, and the thermodynamic processes. Construct pressure versus volume diagrams for the various thermodynamic processes.*
4. *State the first and second law of thermodynamics and apply them to thermodynamic processes.*
5. *Concept of calorimetry and working principle of calorimeter and differential scanning calorimetry.*

Teaching Methodology (List methodologies used –example are given below)

Interactive Classes:

1. *Use media to increase student engagement and improve learning outcomes.*
2. *Try adding metaphors to help students remember details.*
3. *Give students a real-world context with extra projects to reinforce skills.*
4. *Provide practical practice within your lessons. Making it relatable will do wonders.*

Case based teaching:

Class Participation

Positive, healthy and constructive class participation will be monitored for each class. Particular emphasis will be given to participation during the presentation sessions. The manner in which the question is asked or answered will also be noted. Your behaviour, as business executives in the class will contribute to the class participation marks.

Word of advice

Assignments/ projects are very demanding and time consuming. Since you might be exposed to the real corporate environment, the ensuing reality checks could be demoralizing and frustrating. So you must learn to handle the intra group conflicts and any clash of interests. Unless you start working on the assignments/ projects right away from the very first day you are likely to miss the deadlines.

Participant Responsibilities:

Student should be responsible enough to practice whatever they have learnt during class sessions. They should also implement it to other subjects as well. They are expected to come prepared in the class.

Class activities:

Presentations

After careful analysis, resource person will constitute the groups to achieve balanced heterogeneity among groups, for group assignments/projects and will have the final decision in this regard. Every member of the group is expected to be able to handle all aspects of the assignments. Groups are not allowed to choose presenters for various parts of the presentations; instead resource person will nominate them. Individuals will be judged for their understanding of the topic through question handling. Q/A section of the presentations will way heavily for grading of assignments/ projects.

Team Discussions:

During class, each student will work in a team on discussion questions. Teams will be assigned questions, allowed ten minutes for Internet research, and permitted five minutes to present their results. Points are earned by active participation with your team.

Applied Projects:

This is a project-based course. Regular attendance is the best predictor of success. Students work on projects with detailed instructions, teacher demonstrations and video tutorials. Students can come in during Tutorial to make up missed work.

STUDENTS ARE REQUIRED TO READ AND UNDERSTAND ALL ITEMS OUTLINED IN THE PARTICIPANT HANDBOOK

Class Policy:

Be On Time

You need to be at class at the assigned time. After 10 minutes past the assigned time, you will be marked absent.

Mobile Policy

TURN OFF YOUR MOBILE PHONE! It is unprofessional to be texting or otherwise.

Email Policy

READ YOUR EMAILS! You are responsible if you miss a deadline because you did not read your email.
Participants should regularly check their university emails accounts regularly and respond accordingly.

Class Attendance Policy

A minimum of 80% attendance is required for a participant to be eligible to sit in the final examination. Being sick and going to weddings are absences and will not be counted as present. You have the opportunity to use 6 absences out of 30 classes. Participants with less than 80% of attendance in a course will be given grade 'F' (Fail) and will not be allowed to take end term exams. International students who will be leaving for visa during semester should not use any days off except for visa trip. Otherwise they could reach short attendance.

Withdraw Policy

Students may withdraw from a course till the end of the 12th week of the semester. Consequently, grade W will be awarded to the student which shall have no impact on the calculation of the GPA of the student.A Student withdrawing after the 12th week shall be automatically awarded "F" grade which shall count in the GPA.

Moodle

UMT –LMS (Moodle) is an Open Source Course Management System (CMS), also known as a learning Management System (LMS). Participants should regularly visit the course website on MOODLE Course Management system, and fully benefit from its capabilities. If you are facing any problem using moodle, visit http://oit.umt.edu.pk/moodle. For further query send your queries to moodle@umt.edu.pk

Harassment Policy

Sexual or any other harassment is prohibited and is constituted as punishable offence. Sexual or any other harassment of any participant will not be tolerated. All actions categorized as sexual or any other harassment when done physically or verbally would also be considered as sexual harassment when done using electronic media such as computers, mobiles, internet, emails etc.

Use of Unfair Means/Honesty Policy

Any participant found using unfair means or assisting another participant during a class test/quiz, assignments or examination would be liable to disciplinary action.

Plagiarism Policy

All students are required to attach a "Turn tin" report on every assignment, big or small. Any student who attempts to bypass "Turn tin" will receive "F" grade which will count towards the CGPA. The participants submit the plagiarism report to the resource person with every assignment, report, project, thesis etc. If student attempts to cheat "Turn tin", he/she will receive a second "F" that will count towards the CGPA. There are special rules on plagiarism for final reports etc. all outlined in your handbook.

Communication of Results

The results of quizzes, midterms and assignments are communicated to the participants during the semester and answer books are returned to them. It is the responsibility of the course instructor to keep the participants informed about his/her progress during the semester. The course instructor will inform a participant at least one week before the final examination related to his or her performance in the course.

Course Outline

Course code: **FT 308** Course title: **Thermodynamics**

Program	School of Food and Agricultural Sciences
Credit Hours	3 Credit Hours
Duration	16 weeks
Prerequisites (If any)	To ensure students success in this course, will need to have familiarity with basic concepts of physics. The basic concept of mathematics will also be required to understand the basic calculations involved in solving the basic problems.
Resource Person Name and Email	Dr. Rafiq Ahmad rafiq.ahmad@umt.edu.pk
Counseling Timing (Room#)	
Contact no.	03166021598
Web Links:- (Face book, Linked In, Google Groups, Other platforms)	

Chairman/Director Program

signature…… Date……

Dean's signature…… … Date……

Grade Evaluation Criteria

Following is the criteria for the distribution of marks to evaluate final grade in a semester.

Marks Evaluation	Marks in percentage
Mid-Term (Written/Practical)	20%
Final exam (Written)	35%
Class Participation	5%
Case Study	0%
Lab	15%
Quizzes, projects and presentations	15%
Assignments	10%
Total	**100%**

Recommended Text Books:

1. Yunus A. Cengel, Michael A. Boles. 2016. Thermodynamics, An Engineering Approach Eighth Edition in SI units.
2. Eastop, T. D. 2004. Applied thermodynamics for engineering and technologists (5th ed.) Pearson Education Singapore.
3. Sontagg, R. E. and G. J. Van Wylen. 2010. Fundamentals of thermodynamics (7th ed.), John Willey and Sons, Inc. New York, USA.
4. Muthuraman, S. 2011. Engineering Thermodynamics: Study of Thermodynamic Properties and Applications. VDM Publishing.
5. Hui, Y.H. 2006. Handbook of food science, technology and engineering, Vol-1.CRC Press, Taylor & Francis Group, Boca Raton, Florida, USA.

Course: Thermodynamics **Course code: FT308**

No	Topics to be covered in the course	Learning Objective of this topic	Expected Outcomes from Students	Teaching Method	Assessment Criteria	Deadlines and Homework
1	Introduction to Thermodynamics	Introduction to thermodynamics and the basic reason of studying thermodynamics in BS food science and technology. Different thermodynamics terminologies, thermodynamic systems, definition of thermodynamics properties, unit conversions etc.	Students understand the importance of thermodynamics in Food industry	Lecture/quiz Surprise Questions	Question/answers, discussion, etc	Within a Week
2	Zeroth law of thermodynamics and concept of temperature. Temperature and pressure scales and measurements.	Temperature and pressure are fundamental food process variables. Students will learn the concept of temperature and zeroth law of thermodynamics. Understand, pressure, pressure scale. Students are expected to perform calculations related to temperature and pressure scales.	Students understand the terms pressure and temperature scales and related conversions	Lecture/quiz Surprise Questions	Basic temperature, pressure scale calculations	Within two Week
3	Expansion of solid liquid and gasses	Students will be able to define and describe the concept of thermal expansion of solid, liquid and gasses. Students will be expected to perform the basic calculation of solving the problem related to	Students understand the thermal expansion in solids, liquid and gasses	Lecture/quiz Surprise Questions	Participation in discussion	In first 10 minutes of next class

		linear expansion, areal expansion and volume expansion.				
4	Energy, forms of energy and energy analyses	Energy and different forms of energy, macroscopic and microscopic form energy i.e. kinetic energy, potential energy, heat energy etc. Mechanical energy and forms of mechanical energy (pressure, kinetic and potential energy). Calculation related to conversion of one form of energy into another form of energy.	Students understand the different forms of energy and transformation of energy from one form to another form	Lecture/quiz Surprise Questions	Group discussion	In last 15 minutes of the calls session
5	First law of thermodynamics and principle of law of thermodynamics	Concept of first law of thermodynamics and law of conservation of energy principle. Detail concept of terms in first law of thermodynamics (Internal energy, heat supplied to or from the system and work done on or by the system) and their sign conventions. Concept of heat supplied at constant pressure and enthalpy. Energy balance concept for open and close system and calculations of energy balance for simple food processes (Blanching, evaporation, mixing etc).	Students understand the first law of thermodynamics and law of conservation of energy. How it is applied in energy balance problem in food industry	Lecture/quiz Surprise Questions	Question answer and discussion	

6	Gas laws and KMT	State of matters, Introduction to gases. Measurable properties of gasses and characteristics of gases. Kinetic molecular theory of gases, basic assumption of kinetic molecular theory of gasses. How kinetic molecular theory explains the behavior of gasses. Ideal gas laws and their derivation, derivation of combine gas law from ideal gas laws.	Students understand the basic assumption of kinetic molecular theory and how does it explain the ideal gas laws	Lecture/quiz Surprise Questions	quiz	Within two weeks
7	Midterm Evaluation	Midterm evaluation		Exam	Exam	
8	Compressibility factor and deviation of real gases from ideal behavior	Compressibility factor, A measure of deviation from ideal gas behavior. More in detail, what is ideal gas behavior and why real gasses deviate from ideal behavior. The inclusion of compressibility factor (z) ideal gas equation to measure the deviation from ideal gas behavior at given temperature and pressure. Concept of critical temperature and critical pressure to determine the reduced temperature and reduced pressure	Students understand why do real gases deviate from ideal gas behavior and	Lecture/quiz Surprise Questions		

		where all gasses show same compressibility factor.				
9	Properties of pure substance	Properties of pure substance, relationship between P, V and T. PVT diagram	Students understand how phase change of pure substance based on pressure, temperature and volume change. Application in extraction techniques	Lecture/quiz Surprise Questions		
10	Group presentations	Group presentations		Presentation	Presentation slides/communication/concepts	
11	Thermodynamics process and thermodynamics cycles	Thermodynamic state and state variables and concept of system at thermodynamic equilibrium. Thermodynamic process and thermodynamic cycle. Calculate physical quantities, such as the heat transferred, work done, and internal energy change for isothermal, adiabatic, isochoric and isobaric thermodynamic processes (Construction of Pv diagram and 1st law of thermodynamics applied to thermodynamics process)	Students understand how thermodynamics process are applied in refrigeration using PV diagram	Lecture/quiz Surprise Questions		

12	Heat transfer	Heat transfer in Food processing, Thermal properties of foods, heat transfer mechanism, Conduction of heat through single and compound walls and tubular pipes	Students understand the heat transfer mechanism and where are they applied in various food processes	Lecture/quiz Surprise Questions	Discussion on various case based discussion related to food processes	In last 15 minutes
13	Heat transfer	Heat transfer in Food processing, Thermal properties of foods, heat transfer mechanism, Conduction of heat through single and compound walls and tubular pipes	Students understand the heat transfer mechanism and where are they applied in various food processes	Lecture/quiz Surprise Questions	Discussion on various case based discussion related to food processes	In last 15 minutes
14	Quiz	Quiz		Detail quiz	Detail quiz	One week after topics announcement
15	Calorimetry	Calorimetry, working principle of calorimeter and Differential scanning calorimetry for the determination of heat contents and specific heat capacity	Students understand how the DSC works using the concept of calorimetry. Its application in food industry	Lecture/quiz Surprise Questions		
16	Revision	Revision				

Lab components:

Experiment 1: Dimensions and unit conversions.
Experiment 2: Perform calculations on problems involving pressure scales based on u-tube manometer attached to any fluid.
Experiment 3: Types of pressure gauge, working principle and how to calibrate the pressure gauge.
Experiment 4: Energy and material balance calculations based on simple food processes. i.e. evaporators, drying, mixing etc.
Experiment 5: Determination of heat contents for different foods and vegetables.
Experiment 6: Determination of relationship between pressure and volume of an ideal gas.
Experiment 7: Determination of relationship between pressure and temperature of an ideal.