

Part A PhD Comprehensive Exam Questions

Thermodynamics Field

A.M. Birk

2006

Exam Content:

Mech 230 introduces the basics of thermodynamics. It focuses on the first seven chapters of this textbook and then deals with introductory concepts in Chapters 8 to 10. Chapters 8 to 10 are covered in greater detail in Mech 330 along with subsequent chapters. Graduate students wishing to prepare for their comprehensive exams in Thermodynamics are advised to read the following chapters that are covered through both courses:

M.J. Moran and H.N. Schapiro. Fundamentals of Engineering Thermodynamics (5th Edition). Wiley, 2004.

Chapters 1-10, 12-13.

1. Introductory Concepts and Definitions
2. Energy and the First Law of Thermodynamics
3. Evaluating Properties
4. Control Volume Analysis Using Energy
5. The Second Law of Thermodynamics
6. Entropy
7. Exergy Analysis (to page 327)
8. Vapour Power Systems
9. Gas Power Systems (to page 451)
10. Refrigeration and Heat Pump Systems

12. Ideal Gas Mixture and Psychrometric Applications
13. Reacting Mixtures and Combustion (up to page 680)

Example Questions:

The following are typical examples of questions:

- 1) Draw a P-V diagram for a reciprocating compressor and explain?
- 2) What is a property?
- 3) What is work? Why is it path dependant?
- 4) Derive the expression for reversible work from a closed system containing a simple compressible substance.
- 5) Draw a piston in a cylinder. The enclosed volume contains liquid water and water vapour in equilibrium. Describe what would happen if heat were added if:
 - a. The piston were held fixed in place.
 - b. The piston were allowed to move to maintain constant pressure in the cylinder
- 6) Derive an expression for reversible shaft work for an open flow system.
- 7) Draw P-v and T-s diagrams for water.
- 8) What is the first law for a control volume? Where did h come from ?
- 9) Analyze a throttle valve.

- 10) Analyze a nozzle.
- 11) Analyze a turbine.
- 12) Why is heat transfer through a finite temperature difference irreversible.
- 13) What is available energy?
- 14) What is a simple compressible substance? What is the state principle for a simple compressible substance?
- 15) What is intercooling in a compression process? Why does intercooling reduce the work needed to compress a gas?
- 16) Why do you need a condenser in a vapour power cycle?
- 17) Describe the Carnot cycle. Is it the only reversible cycle?
- 18) What is psychrometer and how does it work.
- 19) What is the wet bulb temperature?
- 20) What is the dew point?
- 21) What is adiabatic saturation?
- 22) What is excess air in combustion? Why would we use it?
- 23) Write the combustion balance equation for propane with 100% excess air.

All of the above questions are open-ended and may be expanded with supplementary questions – for example:

Analyze a throttle valve.

What is a throttle used for?

What does it look like inside?

Why is the throttle not isentropic?

Why can we ignore changes in kinetic energy?

If air is throttled will it cool down? ($h_1 = h_2$ then $T_1 = T_2$? is this correct?)

The websites for both courses contain excellent notes that summarize the content of the textbook. They also feature solutions to assignment, tutorial and midterm problems that students are advised to review. The course websites are:

<http://me.queensu.ca/courses/mech230/>

<http://me.queensu.ca/courses/mech330/>