

King Fahd University of Petroleum & Minerals
MECHANICAL ENGINEERING DEPARTMENT
ME 438: Pumping Machinery

Catalogue Description: (3-0-3)

Terminology and description of typical pump machinery. Momentum and energy transfer between fluid and rotor; Performance characteristics of centrifugal and axial flow fans, compressors and pumps; Various types of losses; Axial and radial thrust in dynamic pumps and thrust balancing devices; Common problems in centrifugal pump operation; Positive displacement pumps; Water hammer problems in pump systems; Special problems in pump design and applications.

Status in Curriculum (Required or Elective): Elective

Prerequisites: ME 311

Co-requisites: None

Prerequisites by Topics:

- Kinematics of fluid flow (ME311)
- Pressure variation in flowing fluids (ME311)
- Momentum and energy conservation principles (ME311)
- Dimensional analysis and similitude (ME311)
- Fundamentals of flow in conduits (ME311)
- Irreversibilities in flow processes (ME203)

Textbook: Pumping Machinery Theory and Practice by H.M. Badr and W.H. Ahmed, First Edition, John Wiley & Sons, 2015.

References:

- 1) N. S. G. Ra, Fluid Flow Machines, McGraw-Hill, 1988.
- 2) O. E. Falje, Turbomachines: A Guide to Design, Selection and Theory, Wiley 1981.
- 3) V.S. Lobanoff and R.R. Ross, Centrifugal Pumps: Design and Applications, 2nd Edition, Gulf Professional Publishing, 1992.
- 4) C. E. Brennen, Hydrodynamics of Pumps, Oxford University Press, 1994.
- 5) P.C. Tramm and R.C. Dean, Centrifugal Compressors and Pump Stability, Stall, and Surge, ASME Publication, 1976.
- 6) J. Stefanoff, Centrifugal and Axial Flow Pumps, John Wiley & Sons, 1957.

Coordinator: Dr. Hassan M. Badr, Professor of Mechanical Engineering

Goals:(general objectives)

The purpose of this course is to

1. Introduce the basic principles underlying all forms of pumping machinery.
2. Conduct a full analysis of the performance characteristics of various types of pumps, fans, and compressors including the operational-type problems.
3. Introduce the main design aspects of various types of pumps, fans, and compressors.

Course Outline (Lecture Topics):

1. Introduction, classification of pumps, definitions and terminology, affinity laws (2 hours)
2. Characteristics of various types of pumps and analysis of pumping systems (4 hours)
3. Energy transfer between pump rotor and fluid, theoretical performance and analysis of various types of losses (6 hours)
4. Axial and radial thrusts and related design considerations (3 hours)
5. Common problems in centrifugal pump operation(6 hours)
6. Axial flow pumps(3 hours)
7. Reciprocating and rotary displacement pumps (6 hours)
8. Pump selection guidelines (2 hours)
9. Introduction to centrifugal fans and compressors(7 hours)

Design Activities/Projects:

Design considerations of pumps and pumping systems are embedded in all lectures and HW's.

Computer Usage:

Students are encouraged to solve some assigned HW's using the available engineering software.

Laboratory Demonstrations, Field Trip and Seminars (6 hours):

- Experimental set up for pump performance test and data analysis
- Demonstration of some special effect pumps and multi-stage centrifugal compressor
- A field trip is arranged every semester to one of the nearby industries.
- Every two students present a seminar on a selected topic in the area of pumping machinery.

Assessment Tools:

Four Quizzes, Two Major Exams, Homework Assignments, Seminars, Final Exam

Course Learning Outcomes:

After taking this course, students will be able to:

- I- Understand the function and performance of the main components of a pumping system.
- II- Understand of main principles of energy transfer in pumps, fans and compressors.
- III- Understand the main design features for radial-, mixed-, and axial-flow pumps.
- IV- Understand the effect of pump components design on various types of losses and factors causing deviation from theoretical characteristics.
- V- Understand the performance characteristics of various types of pumps and analysis of different methods of flow rate control.
- VI- Understanding the effect of pumping system design on a wide range of operational-type problems.
- VII- Demonstrate experimental flow loops for performance characteristics of a pump, a fan and a compressor.
- VIII- Select the proper pump for a specific application and the proper method for flow rate control.
- IX- Perform design modifications for changing the performance characteristics for a given pump.
- X- Conduct a performance analysis of a centrifugal compressor and solve various operational-type problems.
- XI- Carry out various design tasks for solving operational-type problems in different pumping systems.
- XII- Take part in technical discussions and prepare the material for a seminar in a topic of relevance to pumping machinery. Seminar presentation and discussions are mandatory.
- XIII- Think as an engineer for solving problems that may arise in the areas of pumping machinery.

Course Learning Outcomes mapped to Student Outcomes:

Student Outcomes	a	b	c	d	e	f	g	h	i	j	k
Course-to-Student outcome mapping	II,IV, X		III, IV, VI,VIII, IX,XI		II,IV, X,XIII		XII, XIII	V,V I, IX	XII		VII
Emphasis*	S		S		M		M	M	S		M

* L:: Little/None M: Moderate S: Strong

Status of Continuous Improvement review of this Course:

Date reviewed:
Prepared by: Dr. Hassan Badr

Reviewed by:
Date prepared: March 8th, 2015