**Birzeit University - Faculty of Engineering & Technology**

**Mechanical & Mechatronic Engineering Department**

**ENMC4411 Thermal Fluid Engineering**

**Course Outline**

**First Semester 2022/2023 Schedule: S 11:25-12:25 and T, R 11:25-12:40**

**Instructor: Dr. Afif Akel, Office 323/4, Tel 2982115, ahasan@birzeit.edu**

**Course description**

Fluid mechanics principles for control volume; mass and energy conservation, pipe flow, pumps. Principles of heat transfer: steady state conduction and fins, forced and natural convection, cooling of electronic components. Air- water vapor mixtures, some power and refrigeration cycles. Combustion and ICE. Fans and compressors. Prerequisite: ENME232, ENME333

**Textbook and references**:

* Moran, M., Shapiro, H., Munson, B. and DeWitt D. Introduction to Thermal Systems Engineering. John Wiley & Sons, Inc., 2003.
* Incropera & De Witt. Fundamental of heat transfer, Wiley & Sons 2005.
* Van Wilyn, and Sontag, Fundamental of classical thermodynamics, Wiley & Sons 2006.
* White, F., Chiu-On Ng, Saroj Saimek. Fluid Mechanics, 7th. Ed, McGrew Hill 2011.

**Specific goals for the course:**

Intended Learning Outcomes:

By the end of this course the student should be able to

* Understand basic fluid notations.
* Calculate pressure variation, in static fluid, and know pressure measuring devices.
* Apply mass conservation equation on a control volume.
* Apply energy equation to a control volume.
* Apply Bernoulli's equation to frictionless flow.
* Apply Linear momentum principles on control volumes.
* Understand and formulate dimensional analysis and similarity principles on fluid mechanics.
* Solve simple pipe problems.
* Describe operating principles, power and efficiency of pumps.
* Select pumps for given application and using pumps catalogues.
* Distinguish different types of fans, and carry out fan performance calculations
* Know various types of compressor and the difference between them.
* Evaluate compressors performance.
* Solve one-dimensional conduction problems with and without heat source
* Understand and solve problems for heat transfer from fins
* Calculate forced convection heat transfer coefficients for internal and external flows
* Calculate the natural convection heat transfer from different surfaces
* Analyze cooling of electronic components and systems.
* Find air properties using psychometric chart, then understand air conditioning processes.
* Analyze power cycles including Rankine, and air standard cycles.
* Analyze vapor compression cycles.
* Apply first law analysis of combustion systems

**Course Content**

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| **Main Topic** | **Content** | **Lectures** | **Reference** |
| Thermal System Engineering | Basic definition of thermal system, components of TSE, thermal system applications. | 1 | Moran et al 2003 Ch 1 |
| Fluid mechanics | Fluid definitions | 1 | White et al 2011 ch 1 |
| Fluid statics | 2 | White et al 2011 ch 2, Moran etal 2003 ch 11 |
| Control Volume equations | 4 | White et al 2011 ch 3  Moran etal 2003 ch 12 |
| Dimensional Analysis and Similarity | 2 | White et al 2011 ch 5 |
| Viscous Flow in pipes | 3 | White et al 2011 ch 6  Moran et al 2003 ch 14 |
| Pumps, fans & compressors | 3 | Notes |
| Quiz 1, 2 & exam1 | Fluid mechanics | 2 |  |
|  | Fluid Subtotal | 17 |  |
| Heat transfer | Introduction to heat transfer | 1 | Moran et al 2003 Ch 15 |
| Steady state 1-D conduction  No generation: walls, cylinders spheres  Heat source: wall, cylinder, spheres  Extended surfaces: fins | 5 | Moran et al 2003 Ch 16 |
| External forced convection | 2 | Moran et al 2003 Ch 17 |
| Internal forced convection | 4 |
| Free convection | 2 |
| Electronic component cooling | 2 | Notes |
| Quiz3 , Exam 2 | Heat transfer | 1.5 |  |
|  | Heat subtotal | 17.5 |  |
| Thermodynamics | Air water vapor mixture: psychometric | 3 | Van Wilyn, et al Ch 12 |
| Power cycles | 2 | Moran et al 2003 Ch 9 |
| Refrigeration cycles | 2 | Moran et al 2003 Ch 8 |
| Combustion & ICE | 4 | Van Wilyn, et al Ch 12 |
| Quiz 4 | Thermodynamics | 0.5 |  |
|  | Thermodynamics subtotal | 11.5 |  |
| Final exam | Comprehensive | 1 |  |
| Total |  | 48 |  |

\* 60 minutes lecture

**Grading**

Exams 30%

Quizzes 20%

Course work (assignments, projects, participation) 15%

Final exam 35%