**MAK4033E (12550) GAS DYNAMICS Fall 2020/2021**

**Lecturer** : Prof. Dr. Bedii Özdemir
**Room** : 227, Otomotive Building, 2nd Floor, ITU Ayazağa Campus /ONLINE
**Group** : Fluids Group, Otomotive Building, ITU Ayazağa Campus
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**Ofice Hours** : Mon: 13:30-17:00, Thu: 13:30-17:00, Fri: 13:30-17:00

**Lecture Hours** : Thu: 8:30 am - 11:29 pm (MOB 220) / ONLINE

**Course Content**
Fundamentals of fluid mechanics and thermodynamics. Steady One-dimensional Compressible Flow. Normal Shocks. Fanno ve Rayleigh Lines, Rankine-Hugoniot Relation. Converging-Diverging Nozzle Flows. Adiabatic Flow with Friction in Constant-area Ducts. Isothermal Flow in Long Ducts. Flow through Ducts with Heat Transfer. Oblique Shocks. Mach Waves. Prandtl-Meyer Function and Combination of Shock Waves.

**Course Book**
- Shapiro, A. H. 1953 The Dynamics and Thermodynamics of Compressible Fluid Flow, The Ronald Press. Co.

**References**
- Hodge, B. K. & Koenig, K. 1995 Solutions Manual Compressible Fluid Dynamics with Personal Computer Applications, Prentice Hall.
- Landau, L. D. & Lifshitz, E. M. 1987 Fluid Mechanics; Course of Theoretical Physics, Volume 6, 2nd Edition, Pergamon Press.
- Liepmann, H. W. & Puckett, A. E. 1947 Introduction to Aerodynamics of a Compressible Fluid, John Wiley.
- Oosthuizen, P. H. & Carscallen, W. E. 1997 Compressible Fluid Flow, McGraw-Hill.
- Streeter, V. L. & Wylie, E. B. 1983 Fluid Mechanics, McGraw-Hill.
- Thomson, P. A. 1972 Compressible Fluid Dynamics, McGraw-Hill.
- Tritton, D. J. 1988 Physical Fluid Dynamics, Oxford Univ. Press.

**Course Objectives**
To understand;
- fundamentals of subsonic and supersonic ideal compressible fluid flows,
- isentropic flows in Laval and other nozzles,
- normal and reflected shock waves,
- frictional and adiabatic compressible flows in long, and short and insulated pipes,
- principles of two-dimensional supersonic flows.

**Course Outcomes**
Ability to;
- formulate and solve problems in one dimensional steady compressible flows,
- solve the problems of steady isentropic flow of ideal gases in Laval nozzles,
- calculate the change in pressure, density and temperature for flows through normal and reflected shock waves,
- solve the problems of adiabatic frictional (Fanno) flows in long constant area ducts,
- solve the problems of frictional , uninsulated (isothermal) constant area duct flows,
- solve the problems of frictionless flows with heat transfer (Rayleigh) in short ducts,
- solve oblique shock wave problems of supersonic flows around wedge shaped bodies and concave corners,
- determine the change in flow conditions through a Prandtl Meyer expansion wave.

**Course Plan**

| Week | Topics |
|---|---|
| 1 | Thermodynamic Relations, Speed of Sound and Mach number, Karman Rules for Supersonic Flows |
| 2 | Fluid Particle and Continuum Hypotheses, Continuity, Momentum and Energy Equations, Compressibility Condition |
| 3 | Fluid Particle and Continuum Hypotheses, Continuity, Momentum and Energy Equations, Compressibility Condition |
| 4 | Steady One-dimensional Compressible Flow |
| 5 | Normal Shocks |
| 6 | **1st Midterm 26 November 2020** |
| 7 | Fanno ve Rayleigh Lines, Rankine-Hugoniot Relation |
| 8 | Converging-Diverging Nozzle Flows |
| 9 | Adiabatic Flow with Friction in Constant-area Ducts |
| 10 | Isothermal Flow in Long Ducts |
| 11 | Flow through Ducts with Heat Transfer |
| 12 | 2nd Midterm **7 January 2021** |
| 13 | Oblique Shocks |
| 14 | Mach Waves |
| 15 | Prandtl-Meyer Function and Combination of Shock Waves |

**Exams & Course Work**

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|---|---|---|
| **Midterms** | 2 | 30% |
| **Homework Assignments** | 4 | 10% |
| **Term Project** | 1 | 30% |
| **Final Exam** | 1 | 30% |

**Note:** ***Please follow* www.akis.itu.edu.tr *for any announcement*.**

**TERM PROJECT WILL BE THE SIMULATION OF A SUPERSONIC FLOW WITH AN OPEN SOURCE CODE OpenFOAM. Meshing will be done with SnappyHexMesh.**
**A FULL REPORT WILL BE REQIRED (including sections as follows; Abstract, Introduction and Literature Survey, Governing Equations, Numerical Methods and Mesh Details, Discussions, and Conclusions). The geometry and the flow conditions will be defined in the first lecture. If necessary, an oral presentation will be required.**