RKUNIVERSITY

SYLLABUS

Course Title	ADVANCED GAS DYNAMICS
Course Code	TH112
Course Credit	Lecture : 04
	Practical : 01
	Tutorial : 00
	Total : 05

Course Objective

- To help the students understand the underlying physical mechanisms of compressible fluid flow and differentiate with respect to incompressible fluid flow hereby to necessitate the applications of compressible fluid flow in the real world engineering problems.
- Understand the generalized equations governing the fluid flow with the help of example problems and also relate these equations with incompressible fluid flow.
- To make the students understand about the knowledge of shock theory its practical application in the field of nozzles and other mechanical related fields.
- To explain the students the importance of dimensional analysis and apply the concepts in the real world.
- Explanations and application of the concept of fanno flow and Rayleigh flow for complex flow situations in compressible fluid flow.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Review of fundamentals :** • Types of flow; Generalized continuity equation; momentum and energy equations. • Euler and Navier-Stokes equations, integration of the momentum equation. • The generalized Bernoulli's equation. • Velocity of sound and its importance; physical difference between incompressible, subsonic and supersonic flows; three reference speeds; dimensionless velocity; concepts of static and stagnation parameters.	**10**
2	**Dimensional analysis and similitude.** • Buckingham theorem. • Rayleigh's method of dimensional analysis • Dimensional analysis; model study. • Compressible flow of viscous fluids.	**9**

3	**The Energy Equation** • Energy equations for flow and non-flow process, Adiabatic energy equation. • Stagnation parameters and state. • Reference velocity, Bernoulli equation, effect of mach number on compressibility.	**5**
4	**Isentropic flow with variable area.** • Comparison of Isentropic and Adiabatic processes, Mach number variation. • Stagnation and Critical states, Area ratio as function of Mach number. • Mass flow rate, flow through nozzles and diffusers. Use of Gas tables.	**4**
	Total	**28**
	SECTION-II	
5	**Flow with Normal Shock Waves.** • Development of a shock wave. The governing equations. • Prandtl-Meyer relation. • Mach number downstream of the normal shock wave. • Static pressure ratio across the shock. • Temperature and density ratio across the shock. • Stagnation pressure ratio and change in entropy across the shock. • Impossibility of a shock in subsonic flow, strength of a shock wave, Determination of mach number of supersonic flows. • Tables and charts for normal shock waves.	**12**
6	**Oblique Shock waves.** • Oblique shock relations from the normal shock equations. • Gas tables for oblique shocks.	**3**
7	**Fanno flow** • The fanno curves, equations and solutions of equations. • Variations of flow properties • Variations of mach number with duct length. • Tables and charts for fanno flow. • Isothermal flow with friction.	**9**
8	**Rayleigh flow** • The Rayleigh line, Fundamental equations, Rayleigh flow relations • Variation of flow properties, Maximum heat transfer. • Tables and charts for Rayleigh flow.	**4**
	Total	**28**

Instructional Method and Pedagogy:

- At the beginning of course, the course delivery pattern prerequisite of the subject will be discussed.
- Lectures will be conducted with the aid of multi-media projector blackboard, OHP etc.
- Attendance is compulsory in lectures and laboratory.
- Minimum two internal exams will be conducted and average of two will be considered as a part of overall evaluation.
- Assignmentsbasedoncoursecontentwillbegiventothestudentsattheendof each unit/topic and will be evaluated at regularly.
- Surprise tests/Quizzes/Seminar/Tutorials will be conducted.
- The course includes a laboratory, where students have a no opportunity to build an appreciation for the concepts being taught in lectures.
- Tutorials and assignments are to be submitted as term-work in laboratory related to course contents.

Students Learning Outcomes:

At the end of the course the students will be able to understand:

- The concepts of compressible fluid flow and difference between compressible and incompressible fluid flow.
- The fundamentals of shock theory in case of compressible fluid flow which will be helpful for students in combustion engineering and also flow through pipes.
- And identify, solve and analyze problems related to shock theory for nozzles.
- Application of concepts of fanno flow and Rayleigh flow for solving the real world engineering problems.

Reference Books:

1. Gas dynamics, Ali Campbell & lennings.
2. Gas dynamics, Radha Krishnan , PHI
3. Fundamentals of compressible flow, S.M. Yahya, New Age Pub
4. The Phenomena of Fluid, Brodkey Addition Wesley Motion
5. Foundation of Fluid, Yuan Prentice Hall Mechanics
6. Gas Dynamics, Maurice Joseph Zucrow, Joe D. Hoffman, Krieger Pub. Co.