Gas Dynamics

Swayam Prabha Course Code: M76

PROFESSOR'S NAME	Prof. T.M. Muruganandam
DEPARTMENT	Department of Aerospace Engineering
INSTITUTE	Indian Institute Of Technology Madras
COURSE OUTLINE	Review of Fundamentals: Concepts from Fluid Mechanics, Basic Thermodynamic Relations Compressible flow: Concept of Waves in fluid, Mach waves, Compression waves, Expansion waves Basic Flow features: Isentropic flow, Shock waves, Stationary and Moving Shocks, Oblique Shocks, Bow Shocks, Expansion Fans Example flows: Flow around bodies, Shock expansion method for flow over airfoils. Flow Through a nozzle: Convergent Nozzles, CD Nozzles, Exit Pressure variation vs Stagnation pressure variation. Oblique shock wave reflections, Jet flows Under- and over-expanded flows Shear layers Other Non-isentropic flows Flow with Friction, Friction choking Flow with heat addition, Thermal choking Supersonic combustion Experimental Methods Shock Tube, Supersonic Wind tunnel, Flow visualization, Supersonic Probes. Methods of characteristics. Design of nozzles, External flow around bodies Experimental characteristics of airfoils in compressible flow. Unsteady flows.

COURSE DETAILS

S. No	Module ID/ Lecture ID	Lecture Title/Topic
1.	L1	Compressibility and Thermodynamics
2.	L2	Thermodynamics
3.	L3	Thermodynamic Processes, Mass and Momentum Conservation Equations
4.	L4	Momentum and Energy Equations
5.	L5	Equations
6.	L6	Energy vs. Momentum Equations, Pressure Waves in Gases

7.	**L7**	Pressure Waves in Gases
8.	**L8**	Communication in Gases, Stagnation state
9.	**L9**	Stagnation Properties, Differential Form Equations For One Dimensional Flow, Isentropic Flow with Area Variation
10.	**L10**	Isentropic Flow with Area Variation (Relations and Solved Examples)
11.	**L11**	Normal Shock Concepts, Normal Shock Relations
12.	**L12**	Normal Shock Relations - I
13.	**L13**	Normal Shock Relations - II
14.	**L14**	Normal Shock Relations, Moving Shocks
15.	**L15**	Moving Shocks, Solved Examples for Stationary Normal Shocks
16.	**L16**	Solved Examples for Stationary and Moving Shocks
17.	**L17**	Solved Numerical Examples for Moving Shocks
18.	**L18**	Solved Numerical Examples for Moving Shocks, Oblique Shock
19.	**L19**	Oblique Shock
20.	**L20**	Oblique Shock Relations
21.	**L21**	Oblique Shocks, Bow Shock
22.	**L22**	Detached Shocks, Oblique Shock Reflections, Numerical Examples
23.	**L23**	Shock-Shock Interations, 1D Expansion Wave, Expansion Fans
24.	**L24**	Expansion Fan, Prandtl-Meyer Angle, Smooth Compressions, Prandtl Meyer Function
25.	**L25**	Prandtl-Meyer Function, Numerical examples, Shock-Expansion Theory
26.	**L26**	Prandtl-Meyer Function, Shock-Expansion Theory and It's Applications
27.	**L27**	Quasi-1D Flow With Area Variations, Choked Conditions

28.	**L28**	Quasi-1D Flow With Area Variation, Geomatric Choking, Numerical examples
29.	**L29**	Convergent Nozzle, Divergent Nozzle, Convergent-Divergent Nozzle
30.	**L30**	Convergent-Divergent Nozzle
31.	**L31**	C-D Nozzle Numerical example, Multiple Choking Points
32.	**L32**	Supersonic Jet
33.	**L33**	Supersonic Jet, Numerical examples
34.	**L34**	Supersonic Jet, Numerical examples, Shear Layers Flow
35.	**L35**	Non-Isentropic Flows-Crocco's Theorem
36.	**L36**	Non-Isentropic Flows-Crocco's Theorem, Fanno Flow
37.	**L37**	Fanno Flow – Relations, Plots and Discussion About Choking
38.	**L38**	Fanno Flow – Numerical examples
39.	**L39**	Non-Isentropic Flows – Rayleigh Flow
40.	**L40**	Rayleigh Flow – Relations, Plots and Discussion
41.	**L41**	Rayleigh Flow, Numerical Example; Non-Isentropic Flows – Various Choking Mechanisms In Compressible Flow, Supersonic Combustor Flow, Ram Jet Flow
42.	**L42**	Shock Tube - I
43.	**L43**	Shock Tube - II
44.	**L44**	Compressible Flow Facilities - I
45.	**L45**	Compressible Flow Facilities - II
46.	**L46**	Compressible Flow Facilities, Measurement Techniques for Compressible Flows, Experiment Design
47.	**L47**	High Speed Flow Visualisation - I
48.	**L48**	High Speed Flow Visualisation - II
49.	**L49**	High Speed Flow Visualisation, Method of Characteristics
50.	**L50**	Directions, Constitutive Relations, Subroutines

51.	**L51**	Subroutines, Marching Techniques, examples
52.	**L52**	2D Method of Characteristics
53.	**L53**	Summary of Course, Unsteady Flow Phenomena
54.	**L54**	Unsteady Flow Phenomena Videos, MOC Simulations

List of reference material/ books:

Liepmann, H.W., and Roshko,A.Elements of Gas Dynamics Dover Publications, Inc., Mineola, NY, USA.

Oosthuizen,P.H., and Carscallen, W.E., Compressible Fluid Flow McGraw-Hill international editions, McGraw-Hill Companies, Inc., Singapore.

Babu V. Fundamentals of Gas Dynamics Ane Books India, Chennai.

Chapman A.J. and Walker W.F. Introductory Gas Dynamics Holt, Reinhart and Winston, Inc. NY, USA.

Name and contact details of two referees for the course: