4/4 B.Tech. EIGHTH SEMESTER

ME8T3A GAS DYNAMICS AND JET PROPULSION Credits: 4

Lecture:- 4 periods/week **Internal assessment: 30marks**
Tutorial: -- **Semester end examination: 70 marks**

Objectives:

1. Define basic concept and importance of gas dynamics
2. Interpret the flow pattern in flow and non flow systems
3. Identify the thrust equation and its usage in jet aircraft and rocket propulsion in an efficient way

Learning outcomes:

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

1. Explain basic concepts of gas dynamics
2. Describe the basic fundamental equations of one dimensional flow of compressible fluid and isentropic flow of an ideal gas.
3. Analyze the steady one dimensional isentropic flow, frictional flow and isothermal flow.
4. Express the concepts of steady one dimensional flow with heat transfer.
5. Discuss the effect of heat transfer on flow parameters.
6. Reproduce knowledge in jet propulsion engines and rockets.

Pre-Requisite

Basic thermodynamics, Heat transfer.

UNIT I

INTRODUCTION TO GAS DYNAMICS:

control volume and system approaches acoustic waves and sonic velocity - Mach number - classification of fluid flow based on mach number - mach cone-compressibility factor - General features of one dimensional flow of a compressible fluid - continuity and momentum equations for a control volume.

UNIT II

ISENTROPIC FLOW OF AN IDEAL GAS:

basic equation - stagnation enthalpy, temperature, pressure and density-stagnation, acoustic speed - critical speed of sound dimensionless velocity-governing equations for isentropic flow of a perfect gas - critical flow area.

UNIT III

STEADY ONE DIMENSIONAL ISENTROPIC FLOW:

nozzles -area change effect on flow parameters -chocking- convergent nozzle - performance of a nozzle under decreasing back pressure -De lavel nozzle - optimum area ratio, - effect of back pressure – nozzle discharge coefficients - nozzle efficiencies.

UNIT IV

SIMPLE FRICTIONAL FLOW:

governing equations for Adiabatic flow with friction in a constant area duct- fanno line limiting conditions - effect of wall friction on flow properties in an Isothermal flow with friction in a constant area duct governing equations - limiting conditions, numerical problems.

UNIT V

STEADY ONE DIMENSIONAL FLOW WITH HEAT TRANSFER:

governing equations - Rayleigh line entropy change caused by heat transfer - conditions of maximum enthalpy and entropy.

UNIT VI

EFFECT OF HEAT TRANSFER ON FLOW PARAMETERS:

Intersection of Fanno and Rayleigh lines. Shock waves in perfect gas- properties of flow across a normal shock - governing equations - Rankine Hugoniat equations - Prandtl's velocity relationship - converging diverging nozzle flow with shock thickness – shock strength.

UNIT VII

JET PROPULSION:

Air craft propulsion: - types of jet engines – thrust equation, Effect of pressure, velocity and temperature changes of air entering compressors, thrust augmentation methods, Performance of turbo propeller engines, ramjet and pulsejet, scramjet engines.

UNIT VIII

ROCKET PROPULSION -

rocket engines, Basic theory of equations - thrust equation - effective jet velocity - specific impulse - rocket engine performance - solid and liquid propellant rockets - comparison of various propulsion systems.

Learning resources

Text books:

1. Modern Compressible flow- Anderson, by J.D-McGraw Hill- 2003.
2. Gas Turbine Theory, by H. Cohen, G.E.C. Rogers and Saravanamutto-Longman Group Ltd.-1980.
3. Fundamentals of Compressible Flow, by S.M. Yahya-New Age International (P) Limited-1996.
4. Principles of Jet Propulsion and Gas Turbines, by N.J. Zucrow-John Wiley, New York,-1970.

Reference books:

1. Compressible fluid flow, by A. H. Shapiro- The Ronald Press, New York-2002
2. Fundamentals of compressible flow with aircraft and rocket propulsion, by S. M.Yahya- New Age International (P) Ltd.-2007
3. Elements of gas dynamics, by Liepman & Roshko- Wiley, New York-1957
4. Aircraft & Missile propulsion, by Zucrow- Wiley,New York- 1958
5. Gas dynamics, by M.J. Zucrow & Joe D.Holfman- Krieger Pub. Co.-1985