



ROCKET PROPULSION

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INTENDED AUDIENCE : BE/ME/MS/MSc/PhD

INDUSTRIES APPLICABLE TO : DRDO, ISRO, HAL, Space and Defense-related industries

COURSE OUTLINE :

The fundamental aspects of rockets and the current trends in rocket propulsion are dealt with in this course. Starting with description of motion in space, the requirements of rockets for placing space-crafts in different orbits and escaping the gravitational fields of the planets are examined. The operating principles and design aspects of solid propellant, liquid propellant, electrical, nuclear and other types of rockets are dealt with.

ABOUT INSTRUCTOR :

Prof. K. Ramamurthi worked in ISRO and thereafter in the Department of Mechanical Engineering at IIT Madras. He is presently Chairman of the Combustion and Shock Wave Panel (CDSW) of ARMREB in DRDO and Chairman of Extramural Research in Combustion of SERB. His research interests are in detonation, blast waves, combustion instability and thermodynamics.

Prof. V. Nagabhushana Rao is an Assistant Professor in the Department of Aerospace Engineering at IIT Madras. He pursued his Ph.D at Cambridge University, U.K. His research interests include coupled interactions in turbomachines, transition to turbulence, CFD (DNS/LES), combustion and high performance computing.

COURSE PLAN :

Week 1: Chap 1: Motion in Space

Lec 1: Introduction

Lec 2: Motion in Space

Lec 3: Rotational Frame of Reference and Orbital Velocities

Week 2: Chap 2 : Theory of Rockets

Lec 4: Velocity Requirements

Lec 5: Theory of rocket propulsion

Lec 6: Rocket Equation and Staging of Rockets

Week 3: Chap 3: Nozzles

Lec 7: Review of Rocket Principles: Propulsion Efficiency

Lec 8: Examples Illustrating Theory of Rocket Propulsion and Introduction to Nozzles.

Lec 9: Theory of Nozzles

Week 4: Lec 10: Nozzle Shape

Lec 11: Area Ratio of Nozzles: Under Expansion and Over Expansion

Lec 12: Characteristic Velocity and Thrust Coefficient

Week 5: Chap 4: Propellants

Lec 13: Divergence Loss in Conical Nozzles and the Bell Nozzles

Lec 14: Unconventional Nozzles and Problems in Nozzles

Lec 15: Criterion for Choice of Chemical Propellants

Week 6: Lec 16: Choice of Fuel-Rich Propellants

Lec 17: Performance Prediction Analysis

Lec 18: Factors Influencing Choice of Chemical Propellants

Week 7: Chap 5: Solid Propellant Rockets

Lec 19: Low energy liquid propellants and Hybrid propellants

Lec 20: Introduction to Solid Propellant Rockets

Lec 21: Burn Rate of Solid Propellants and Equilibrium Pressure in Solid Propellant Rockets.

Week 8: Lec 22: Design Aspects of Solid Propellant Rockets.

Lec 23: Burning Surface Area of Solid Propellant Grains.

Lec 24: Ignition of Solid Propellant Rockets.

Week 9: Lec 25: Review of Solid Propellant Rockets.

Lec 26: Feed Systems for Liquid Propellant Rockets.

Lec 27: Feed System Cycles for Pump Fed Liquid Propellant Rockets.

Week 10: Lec 28: Analysis of Gas Generator and Staged combustion cycles and introduction to injectors

Lec 29: Injectors, Cooling of Chambers and Mixture Ratio Distribution

Lec 30: Efficiencies due to mixture ratio distribution and incomplete vaporization.

Week 11: Lec 31: Pumps and Turbines: Propellant Feed System at Zero "g" Conditions.

Lec 32: Review of Liquid Bi-propellant Rockets and Introduction to Mono-propellant Rockets.

Lec 33: Introduction to Hybrid Rockets and a Simple Illustration of Combustion instability in Liquid Propellant Rockets.

Week 12: Lec 34: Principles of Electrostatic and Electromagnetic Rockets.

Lec 35: Electrical Thrusters.

Lec 36: Electrical and Nuclear Rockets; Advanced Propulsion.