

NPTEL : Introduction to Aerospace Propulsion (Aerospace Engineering)

Co-ordinators : Prof. Bhaskar Roy, Prof. A M Pradeep

Lecture 1 - Course Intro & Historical development of flights

Lecture 2 - Early development of aircraft propulsive devices

Lecture 3 - Development of Jet propulsion for aircraft

Lecture 4 - Introduction to thermodynamics, Scope and method, Basic concepts: system, surroundings, property, intensive and extensive, state, equilibrium and state postulate, process, path and cycle

Lecture 5 - Quasi-static processes, zeroth law of thermodynamics and temperature, concept of energy and its various forms, internal energy, enthalpy

Lecture 6 - Specific heats at constant pressure and volume Work and heat transfers

Lecture 7 - Tutorial

Lecture 8 - First law of thermodynamics for closed systems

Lecture 9 - First law of thermodynamics for open systems/flow processes

Lecture 10 - Second law of thermodynamics, heat engines, refrigerators and heat pumps, Kelvin-Planck and Clausius statement of second law of thermodynamics

Lecture 11 - Reversible and irreversible processes, concept of entropy

Lecture 12 - Increase of entropy principle, third law of thermodynamics, absolute entropy, perpetual motion machines

Lecture 13 - Tutorial

Lecture 14 - Carnot cycle, Carnot principle, thermodynamic temperature scale

Lecture 15 - Exergy, availability and second law efficiency

Lecture 16 - Tutorial

Lecture 17 - Gas and vapour power cycles, Otto cycle, Diesel cycle, Dual cycle

Lecture 18 - Rankine cycle, Brayton cycle, Stirling and Ericsson cycles

Lecture 19 - Thermodynamic property relations, Jacobean and Legendre transformations, Maxwell's equations

Lecture 20 - Tutorial

Lecture 21 - Properties of gas and vapour mixtures

Lecture 22 - One-dimensional compressible flows, isentropic flows

Lecture 23 - Flows with friction and heat transfer, normal and oblique shocks

Lecture 24 - Piston-prop engines: Otto cycles; Ideal and Real cycles

Lecture 25 - IC Engines for aircraft application

Lecture 26 - Performance parameters of IC engines

Lecture 27 - Supercharging of aircraft IC engines

Lecture 28 - Tutorial: IC Engines

Lecture 29 - Propeller fundamentals

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[Lecture 30 - Propeller aerodynamic theories - I](#)

[Lecture 31 - Propeller aerodynamic theories - II](#)

[Lecture 32 - Tutorial: Propellers](#)

[Lecture 33 - Ideal cycles for Jet engines](#)

[Lecture 34 - Ideal cycles for variants of jet engines](#)

[Lecture 35 - Tutorial](#)

[Lecture 36 - Fundamentals of Ramjets and Pulsejets](#)

[Lecture 37 - Fundamentals of Rocket engines](#)

[Lecture 38 - Fundamentals of Missile engines](#)

[Lecture 39 - Various space vehicles and their engines](#)

[Lecture 40 - Closure of the lecture series : recap](#)

NPTEL : Jet Aircraft Propulsion (Aerospace Engineering)

Co-ordinators : Prof. A M Pradeep, Prof. Bhaskar Roy

- Lecture 1 - Introduction & Development of Jet Aircraft Propulsion
- Lecture 2 - How the Aircraft Jet Engines make Thrust
- Lecture 3 - Jet Engine Basic Performance Parameters
- Lecture 4 - Turbojet, Reheat Turbojet and Multi-spool Engines
- Lecture 5 - Turbofan, Turbo-prop and Turboshift engines
- Lecture 6 - Ideal and Real Brayton cycles
- Lecture 7 - Jet Engine Cycles for Aircraft propulsion
- Lecture 8 - Cycle components and component performances
- Lecture 9 - Tute-1
- Lecture 10 - Analysis of engine real cycles
- Lecture 11 - Tute-2
- Lecture 12 - Thermodynamics of Compressors
- Lecture 13 - Thermodynamics of Turbines
- Lecture 14 - Axial Compressors : two dimensional analytical model
- Lecture 15 - Cascade analysis; Loss and Blade performance estimation
- Lecture 16 - Free Vortex theory; Single-Multi-stage characteristics
- Lecture 17 - Tutes-3
- Lecture 18 - Elements of centrifugal compressor
- Lecture 19 - Centrifugal Compressor characteristics: Surging, Choking
- Lecture 20 - Axial flow turbines; Turbine Blade 2-D (cascade) analysis
- Lecture 21 - Multi-staging: Axial Turbine; Turbine Cooling Technology
- Lecture 22 - Radial Turbine Aerodynamics & Thermodynamics; Losses
- Lecture 23 - Tutes-4
- Lecture 24 - Types of combustion chambers: mechanism & parameters
- Lecture 25 - Pr. Loss, Combustion efficiency; Combustion intensity
- Lecture 26 - Practical combustion system ; Stability, Fuel injection
- Lecture 27 - Intakes for Powerplant: Transport / Military Aircraft
- Lecture 28 - Subsonic, Transonic, Supersonic Intake Designs
- Lecture 29 - Nozzle : fixed and variable geometry nozzles
- Lecture 30 - C-D nozzle and their uses
- Lecture 31 - Tute-5

[Lecture 32 - Engine Off Design Operations](#)

[Lecture 33 - Aircraft Engine component matching: Dimensional analysis](#)

[Lecture 34 - Engine component matching and Sizing](#)

[Lecture 35 - Installed Performance of Engine](#)

[Lecture 36 - Tute-6](#)

[Lecture 37 - Use of Ramjets and Pulsejets in Aircraft propulsion](#)

[Lecture 38 - Thermodynamic Cycle & Performance Parameters](#)

[Lecture 39 - Flow in Diffusers, Combustors and Nozzles](#)

[Lecture 40 - Performace and Design of Ramjet & Scramjet Engines](#)

[Lecture 41 - Tute-7](#)

[Lecture 42 - Future of Aircraft Propulsion](#)

- Lecture 1 - Introduction to Turbo machines Syllabus, References and Schedules
- Lecture 2 - Axial Flow Compressors and Fans : Introduction to Compressor Aerothermodynamics
- Lecture 3 - A two dimensional analytical model :Cascade
- Lecture 4 - 2D losses in Axial flow Compressor Stage : Primary losses
- Lecture 5 - Tutorial 1 : Two Dimensional Axial Flow Compressors
- Lecture 6 - 3D Flows in Blade Passages, Secondary Flows, Tip leakage Flow, Scrubbling
- Lecture 7 - Three Dimensional Flow Analysis : Radial Equilibrium Concept
- Lecture 8 - Classical Blade Design Laws : Free Vortex and other Laws
- Lecture 9 - Three Dimensional Flow Analysis in Axial Flow Compressor
- Lecture 10 - Tutorial 2 : Three Dimensional Axial Flow Compressors
- Lecture 11 - Axial Compressor Characteristics: Single stage, Multi stage and Multi spool Characteristics
- Lecture 12 - Instability in Axial Compressors
- Lecture 13 - Inlet Distortion and Rotating Stall, Control of Instability
- Lecture 14 - Transonic Compressors and Shock Structure Models, Transonic Compressor Characteristics
- Lecture 15 - Axial Flow Compressor Design, Inter Spool Duct
- Lecture 16 - Design of Compressor Blades, Aerofoil Design (Subsonic, Transonic, Supersonic Profiles)
- Lecture 17 - Design of Compressor Blade: 3D Blade Shapes of Rotors and Stators
- Lecture 18 - Noise Problem in Axial Compressors and Fans
- Lecture 19 - Axial Flow Turbines: Introduction to Turbines Aerothermodynamics
- Lecture 20 - Axial Flow Turbines: Turbine Blade 2D (Cascade) Analysis
- Lecture 21 - Axial Flow Turbines: Work done, Degree of Reaction, Losses and Efficiency
- Lecture 22 - Axial Flow Turbines: Blade and Axial Flow Passages, Exit Flow Matching with Nozzle
- Lecture 23 - Tutorial 3 : Axial Flow Turbines
- Lecture 24 - Multi staging and Multi spooling of Turbine
- Lecture 25 - 3D Flow in Turbine: 3D Flow Theories, Free Vortex Theories etc.
- Lecture 26 - Tutorial 4 : 3D Flows in Axial Flow Turbines
- Lecture 27 - Turbine Blade Cooling – Fundamentals of Heat Transfer, Blade Cooling Requirements
- Lecture 28 - Turbine Blade Cooling Technologies
- Lecture 29 - Turbine Blade Design: Turbine Profiles, Aerofoil Data and Profile Construction
- Lecture 30 - Turbine Blade Design: 3D Blade Shapes
- Lecture 31 - Centrifugal Compressors: Thermodynamics and Aerodynamics

[Lecture 32 - Centrifugal Compressors: Characteristics, Stall, Surge Problems](#)

[Lecture 33 - Tutorial 5 : Centrifugal Compressors](#)

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[Lecture 38 - CFD for Turbomachinery: Grid Generation, Boundary Conditions for Flow Analysis](#)

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[Lecture 40 - CFD for Turbomachinery: 2D and 3D Blade Generation and Analysis Using CFD](#)

Lecture 1 - Course Layout and Brief Introduction of Course Instructor

Lecture 2 - Introduction to International Standard Atmosphere (ISA)

Lecture 3 - Pressure, Temperature, Density and Viscosity Variation with Altitude in ISA

Lecture 4 - Other Standard Atmospheres

Lecture 5 - Aircraft Component Nomenclature - Wing and its Components

Lecture 6 - Aircraft Component Nomenclature - Fuselage and its Components

Lecture 7 - Aircraft Component Nomenclature - Tail Plane and its Components

Lecture 8 - Tutorial 1 - Aircraft Component Nomenclature

Lecture 9 - Essentials of Incompressible Flow - Part I

Lecture 10 - Essentials of Incompressible Flow - Part II

Lecture 11 - Bernoulli's Equation and Coanda Effect

Lecture 12 - Mach Number

Lecture 13 - Tutorial 2 - Incompressible Flow and Flow Visualization

Lecture 14 - Viscous Flow and Reynolds Number

Lecture 15 - Introduction to Boundary Layer

Lecture 16 - Pressure Measurement

Lecture 17 - Air Speed Measurement - Pitot Static Tube

Lecture 18 - Air Speed Corrections

Lecture 19 - Altitude and ROC/ROD Measurement

Lecture 20 - Measurements in Compressible Flows

Lecture 21 - Non Pneumatic Instruments

Lecture 22 - Introduction to Aerofoils and Aerofoil Nomenclature

Lecture 23 - Aerofoils - A Visit to the Past

Lecture 24 - Thick Aerofoils

Lecture 25 - Low Reynolds Number Aerofoils

Lecture 26 - Lift Generation by Wings - Part I

Lecture 27 - Lift Generation by Wings - Part II

Lecture 28 - Coefficient of Lift and Coefficient of Pressure

Lecture 29 - Tutorial on Aerofoils

Lecture 30 - Critical Mach Number

Lecture 31 - Wave Drag

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[Lecture 46 - Climbing Flight and Ceiling](#)

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[Lecture 57 - Tutorial on Stability and Control](#)

[Lecture 58 - Range](#)

[Lecture 59 - Specific Fuel Consumption and Generalized Range Equation](#)

[Lecture 60 - Endurance](#)

[Lecture 61 - Take-off Performance of Flight - Part I](#)

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[Lecture 63 - Landing Performance of Flight](#)

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[Lecture 65 - Tutorial on Range and Endurance](#)

[Lecture 66 - Flapping Wing Aerodynamics - Part I](#)

[Lecture 67 - Flapping Wing Aerodynamics - Part II](#)

Lecture 1 - What is Aircraft Design

Lecture 2 - Aircraft Design Process

Lecture 3 - Design Stages

Lecture 4 - Phases in Aircraft Design

Lecture 5 - The Design Spiral

Lecture 6 - Importance of Cost in Aircraft Design

Lecture 7 - Basic Laws of Aircraft Design

Lecture 8 - Requirements Capture

Lecture 9 - Quality Function Deployment

Lecture 10 - House of Quality Chart

Lecture 11 - Example of HoQ for HALE UAV

Lecture 12 - Illustration of HOQ-GA aircraft

Lecture 13 - Airliners

Lecture 14 - Key Issues in Design of Airliners

Lecture 15 - Design Considerations - Future Airliners

Lecture 16 - Supersonic Transport Aircraft

Lecture 17 - Airliner and Supersonic Aircraft, some additional concepts

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Lecture 19 - Design Considerations - GA Aircraft

Lecture 20 - Types of Military Aircraft

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Lecture 23 - Podded Engines on Wings

Lecture 24 - Wing Sweep

Lecture 25 - Canards and Flying Wing

Lecture 26 - Three Surface Aircraft

Lecture 27 - Winglets

Lecture 28 - Thrust Vectoring

Lecture 29 - Few Novel Concepts_01

Lecture 30 - Aircraft Configuration Design - Closing Remarks

Lecture 31 - Choices in Aircraft Layout

- Lecture 32 - Wing Geometry Definitions
- Lecture 33 - Options for Wing layout
- Lecture 34 - Propulsion System Layout
- Lecture 35 - Tail Plane Layout
- Lecture 36 - Landing Gear Layout - Part 1
- Lecture 37 - Landing Gear Layout - Part 2
- Lecture 38 - Landing Gear of some Famous Aircraft
- Lecture 39 - Tutorial on OpenVSP
- Lecture 40 - Initial Sizing in Aircraft Design
- Lecture 41 - Estimation of Empty Weight Fraction
- Lecture 42 - Estimation of Mission Segment Weights
- Lecture 43 - Estimation of Fuel Weight Fractions
- Lecture 44 - Estimation of maximum L/D
- Lecture 45 - Estimation of engine parameters
- Lecture 46 - Estimation of Design gross weight
- Lecture 47 - Take-off weight build up
- Lecture 48 - Tutorial on Initial Sizing of Transport Aircraft
- Lecture 49 - Tutorial on Initial Sizing of Military Aircraft
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- Lecture 51 - Component Buildup Method
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- Lecture 53 - Tutorial on Drag Polar Estimation of Military Aircraft
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- Lecture 56 - Flaps as High Lift Devices
- Lecture 57 - Tutorial on Lift Coefficient Estimation of Transport Aircraft
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Lecture 8 - Impact of Gravity

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Lecture 13 - Constant (T/m) Solution

Lecture 14 - Ascent Mission Design

Lecture 15 - Multi-stage Rocket Basics

Lecture 16 - Multi-stage Configuration Basics

Lecture 17 - Multi-stage Solution Basics

Lecture 18 - Multi-stage Problem Definition

Lecture 19 - Optimal Staging Strategy

Lecture 20 - Lagrange Solution

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Lecture 23 - Variant Design Solution

Lecture 24 - Parallel Staging Concept

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NPTEL : Aero elasticity (Aerospace Engineering)

Co-ordinators : Prof. C. Venkatesan

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NPTEL : Instability and Transition of Fluid Flows (Aerospace Engineering)

Co-ordinators : Prof. Tapan K. Sengupta

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NPTEL : Introduction to Propulsion (Aerospace Engineering)

Co-ordinators : Dr. D.P. Mishra

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Lecture 3 - Why do we need to look at Ancient Indian Science and Technology?

Lecture 4 - Glimpses of Ancient Indian Science and Technology

Lecture 5 - Brief Review of Ancient Indian Scriptures

Lecture 6 - Basic Principles of carrying out science and technology

Lecture 7 - Arrays of Physics, chemistry and Indoor games

Lecture 8 - Marvels of Ancient Indian Technology

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Lecture 11 - Pesticides and soil degradation

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Lecture 13 - An Agricultural Tools - A Plough

Lecture 14 - Soil and seeds

Lecture 15 - Sowing Methods

Lecture 16 - Indigenous cattle and manuring

Lecture 17 - Ancient Indian Textile Technology

Lecture 18 - Handlooms and Charkha

Lecture 19 - Different types of Handlooms

Lecture 20 - Ancient Rural Indian Housing

Lecture 21 - Thatched Roof House

Lecture 22 - Rural Walls and Roof materials

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Lecture 24 - First and Second of Indian Civilization

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- Lecture 2 - Cruise Experiment (Theory)
- Lecture 3 - Weighment Experiment and cockpit panel description
- Lecture 4 - Drag Polar Experiment
- Lecture 5 - CG and Climb Experiment
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- Lecture 21 - Aerodynamic Parameter Estimation using Delta Method (Continued...)

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- Lecture 2 - Thermodynamic property, state, equilibrium and process
- Lecture 3 - Temperature scale and pressure
- Lecture 4 - Macroscopic and microscopic forms of energy
- Lecture 5 - Different forms of work, energy transfer and sign convention
- Lecture 6 - First law of thermodynamics and energy balance
- Lecture 7 - Efficiency of mechanical and electrical devices
- Lecture 8 - Examples on basic concept and energy balance
- Lecture 9 - Phase change of a pure substance
- Lecture 10 - Property diagrams of pure substances
- Lecture 11 - Thermodynamic properties of a pure substance from a property table
- Lecture 12 - Thermodynamic properties of a pure substance
- Lecture 13 - Equations of state and compressibility chart
- Lecture 14 - Examples on properties of pure substances
- Lecture 15 - Quasi equilibrium, moving boundary work
- Lecture 16 - Polytropic process
- Lecture 17 - Energy analysis of closed system and unrestrained expansion
- Lecture 18 - Internal energy, enthalpy, and specific heats of ideal gas
- Lecture 19 - Internal energy, enthalpy, and specific heats of solids and liquids
- Lecture 20 - Examples on energy balance for closed systems and moving boundary work
- Lecture 21 - Conservation of mass and steady flow processes
- Lecture 22 - Flow work and energy of flowing fluid
- Lecture 23 - Energy balance for steady flow devices
- Lecture 24 - Throttling valve, mixing chamber and heat exchanger
- Lecture 25 - Energy analysis of steady and unsteady flow devices
- Lecture 26 - Examples on mass and energy analysis of open systems
- Lecture 27 - Second law of thermodynamics, heat engine and cyclic devices
- Lecture 28 - COP of refrigerator and heat pump, second law statements
- Lecture 29 - Perpetual motion machines, reversible and irreversible processes, Carnot cycle
- Lecture 30 - Carnot principles, thermodynamic temperature scale, Carnot HE and HP
- Lecture 31 - Examples on second law of thermodynamics

Lecture 32 - Clausius inequality, application of second law

Lecture 33 - Entropy, increase in entropy principle, isentropic process

Lecture 34 - Change in entropy of solids, liquids and ideal gases

Lecture 35 - Reversible flow work, multistage compressor, efficiency of pump and compressors

Lecture 36 - Entropy balance in closed system and control volume

Lecture 37 - Examples on entropy change in a system

Lecture 38 - Exergy and second law efficiency

Lecture 39 - Exergy of a fixed mass and flowing stream

Lecture 40 - Exergy transfer due to heat, mass and work, exergy destruction

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Lecture 48 - Rankin and Carnot vapour power cycles

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Lecture 54 - Thermodynamic property relations: Joule-Thomson coefficient and cyclic relations

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Lecture 58 - Examples on property relations and reaction thermodynamics

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Lecture 4 - Range and Endurance

Lecture 5 - Mission Requirements

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Lecture 7 - Fuel Consumption : Cruise Flight

Lecture 8 - L/D for Maximum Range and Endurance

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Lecture 13 - Design Considerations : Wing

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Lecture 23 - Thrust Loading and Wing Loading

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Lecture 25 - Wing Loading

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Lecture 28 - Take off: V_{stall} and High Lift Devices

Lecture 29 - Wing Loading: Take off and Landing

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- Lecture 5 - Properties of liquid and solid fuels, various modes of combustion
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- Lecture 9 - Stoichiometric calculations for air-gas mixture
- Lecture 10 - Mixture fraction calculation for diffusion flames
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NPTEL : Combustion (Aerospace Engineering)

Co-ordinators : Prof. S.R. Chakravarthy

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Lecture 3 - Sensible Enthalpy and Adiabatic Flame Temperature

Lecture 4 - Dissociation of Products, Role of Pressure

Lecture 5 - Numerical Calculation of Adiabatic Flame Temperature, Chemical Kinetics 1

Lecture 6 - Chemical Kinetics 2

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Lecture 8 - Reduced Chemistry, Steady State Approximation

Lecture 9 - Steady State Approximation, Partial Equilibrium Approximation

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Lecture 3 - Equilibrium and stability

Lecture 4 - Static vs dynamic stability

Lecture 5 - Criterion for stability, Wing contribution

Lecture 6 - Horizontal tail contribution

Lecture 7 - Wing plus tail contribution

Lecture 8 - Static margin and CG limits

Lecture 9 - Fuselage contribution

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Lecture 11 - Power effects on neutral point

Lecture 12 - Elevator

Lecture 13 - Stick free stability, Most fwd CG location

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Lecture 15 - Control requirement, Pull-up maneuver, Maneuver point

Lecture 16 - Elevator per 'g', Maneuver point

Lecture 17 - Example problems

Lecture 18 - Lateral-Directional Stability Derivatives, Fuselage/Vertical fin contribution

Lecture 19 - Roll stability, Wing sweep effect, Rudder

Lecture 20 - Dihedral effect, Various contributions

Lecture 21 - Power effects, Roll control, Aileron

Lecture 22 - Example problems

Lecture 23 - Derivation of Translational Motion Equations

Lecture 24 - Derivation of Angular Motion Equations

Lecture 25 - Description of various forces and moments

Lecture 26 - Nonlinearities and Associated Aircraft Behavior

Lecture 27 - Small perturbation method, Linearization of equations

Lecture 28 - Aerodynamic force and Moment Derivatives

Lecture 29 - Contribution of Aircraft components to Aerodynamic Derivatives

Lecture 30 - Linear Model and Aircraft Dynamics Modes

Lecture 31 - Short Period, Phugoid (Lanchester's formulation)

[Lecture 32 - Short period mode approximation](#)

[Lecture 33 - Flying and Handling Qualities, Cooper Harper Scale](#)

[Lecture 34 - Pure rolling motion, Pure yawing motion, Spiral approximation](#)

[Lecture 35 - Spiral, Roll, Dutch roll Mode approximations](#)

[Lecture 36 - Lateral directional Flying Qualities, Routh's Stability criterion](#)

[Lecture 37 - Stability in Steady Roll Maneuver](#)

[Lecture 38 - Wind Effect on Aircraft Pure Plunging Motion](#)

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NPTEL : Gas Dynamics (Aerospace Engineering)

Co-ordinators : Dr. T.M. Muruganandam

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NPTEL : Introduction to CFD (Aerospace Engineering)

Co-ordinators : Prof. M. Ramakrishna

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- Lecture 2 - Representing Arrays and functions on computers
- Lecture 3 - Representing functions - Box functions
- Lecture 4 - Representing functions - Polynomials and Hat functions
- Lecture 5 - Hat functions, Quadratic and Cubic representations
- Lecture 6 - Demo - Hat functions, Aliasing
- Lecture 7 - Representing Derivatives - finite differences
- Lecture 8 - Finite differences, Laplace equation
- Lecture 9 - Laplace equation - Jacobi iterations
- Lecture 10 - Laplace equation - Iteration matrices
- Lecture 11 - Laplace equation - convergence rate
- Lecture 12 - Laplace equation - convergence rate Continued
- Lecture 13 - Demo - representation error, Laplace equation
- Lecture 14 - Demo - Laplace equation, SOR
- Lecture 15 - Laplace equation - final, Linear Wave equation
- Lecture 16 - Linear wave equation - Closed form and numerical solution, stability analysis
- Lecture 17 - Generating a stable scheme and Boundary conditions
- Lecture 18 - Modified equation
- Lecture 19 - Effect of higher derivative terms on Wave equation
- Lecture 20 - Artificial dissipation, upwinding, generating schemes
- Lecture 21 - Demo - Modified equation, Wave equation
- Lecture 22 - Demo - Wave equation / Heat Equation
- Lecture 23 - Quasi-linear One-Dimensional. wave equation
- Lecture 24 - Shock speed, stability analysis, Derive Governing equations
- Lecture 25 - One-Dimensional Euler equations - Attempts to decouple
- Lecture 26 - Derive Eigenvectors, Writing Programs
- Lecture 27 - Applying Boundary conditions
- Lecture 28 - Implicit Boundary conditions
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- Lecture 30 - Roes averaging
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Lecture 3 - Rotational Frame of Reference and Orbital Velocities

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Lecture 8 - Examples Illustrating Theory of Rocket Propulsion and Introduction to Nozzles

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Lecture 10 - Nozzle Shape

Lecture 11 - Area Ratio of Nozzles: Under Expansion and Over Expansion

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Lecture 16 - Choice of Fuel-Rich Propellants

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Lecture 18 - Factors Influencing Choice of Chemical Propellants

Lecture 19 - Low energy liquid propellants and Hybrid propellants Chapter 5: Solid Propellant Rockets

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Lecture 21 - Burn Rate of Solid Propellants and Equilibrium Pressure in Solid Propellant Rockets

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Lecture 26 - Feed Systems for Liquid Propellant Rockets

Lecture 27 - Feed System Cycles for Pump Fed Liquid Propellant Rockets

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Lecture 29 - Injectors, Cooling of Chambers and Mixture Ratio Distribution

Lecture 30 - Efficiencies due to mixture ratio distribution and incomplete vaporization

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