

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](#)

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

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

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

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[Lecture 41 - Tute-7](#)

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

NPTEL : Turbomachinery Aerodynamics (Aerospace Engineering)

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

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](#)

[Lecture 34 - Design of Centrifugal Compressors: Impellers, Vane/Vane less Diffusers, Volute](#)

[Lecture 35 - Radial Turbines: Thermodynamics and Aerodynamics](#)

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[Lecture 37 - Radial Turbine Characteristics and Design of Radial Turbines](#)

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

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- 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

Lecture 32 - Swept Wings

Lecture 33 - Introduction to Drag and Types of Drag

Lecture 34 - Factors Affecting Induced Drag

Lecture 35 - Skin Friction Drag

Lecture 36 - Tutorial on Critical Mach Number and Wave Drag

Lecture 37 - Introduction to Propulsion

Lecture 38 - Gas Turbine Engine Types - Part I

Lecture 39 - Gas Turbine Engine Types - Part II

Lecture 40 - Introduction to Electric Propulsion and Ion Propulsion

Lecture 41 - Steady Level Flight

Lecture 42 - Power Required for the Steady Level Flight

Lecture 43 - Steady Level Flight - A Pilot's View

Lecture 44 - Tutorial on Steady Level Flight

Lecture 45 - Gliding Flight

Lecture 46 - Climbing Flight and Ceiling

Lecture 47 - Introduction to Turning Flight

Lecture 48 - Turning Flight Equations

Lecture 49 - Instantaneous and Sustained Turn

Lecture 50 - Tutorial on Climbing Flight and Turning Flight

Lecture 51 - Introduction to Static Stability: Center of Pressure, Center of Gravity and Neutral Point

Lecture 52 - Aerodynamic Center and Effect of Center of Gravity

Lecture 53 - Effect of Center of Gravity - A Practical Demonstration

Lecture 54 - Introduction to V-n Diagram

Lecture 55 - V-n Diagram as per FAR 23 Regulations

Lecture 56 - Effect of Gusts on V-n Diagram

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

Lecture 62 - Take-off Performance of Flight - Part II

Lecture 63 - Landing Performance of Flight

Lecture 64 - Tutorial on Range Payload Diagram

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

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

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- 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 - Airlines
- Lecture 14 - Key Issues in Design of Airlines
- Lecture 15 - Design Considerations - Future Airlines
- Lecture 16 - Supersonic Transport Aircraft
- Lecture 17 - Airliner and Supersonic Aircraft, some additional concepts
- Lecture 18 - Design Considerations - Cargo Aircraft
- Lecture 19 - Design Considerations - GA Aircraft
- Lecture 20 - Types of Military Aircraft
- Lecture 21 - Cargo, GA and Military Aircraft, Some additional concepts
- Lecture 22 - Aircraft Configuration Design
- 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
- Lecture 52 - Drag Estimation of Military Aircraft
- Lecture 53 - Tutorial on Drag Polar Estimation of Military Aircraft
- Lecture 54 - Estimation of Lift Coefficient
- Lecture 55 - Estimation of Maximum Lift Coefficient
- Lecture 56 - Flaps as High Lift Devices
- Lecture 57 - Tutorial on Lift Coefficient Estimation of Transport Aircraft
- Lecture 58 - Tutorial on Lift Coefficient Estimation of Military Aircraft
- Lecture 59 - Constraint Analysis- Introductory Remarks
- Lecture 60 - Constraint Analysis- Transport Aircraft - Part 1
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[Lecture 77 - Tutorial on Range Payload Diagram of Transport Aircraft](#)

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[Lecture 83 - High Altitude Long Endurance \(HALE\) Aircraft](#)

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[Lecture 85 - Guest Lectuer on Air Power and Multi-role Fighter Aircraft - Part 1](#)

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Lecture 2 - Course Plan

Lecture 3 - Ascent Mission Basics

Lecture 4 - Force and Geometry Models - 1

Lecture 5 - Force and Geometry Models - 2

Lecture 6 - Idealized Performance

Lecture 7 - Trajectory Under Gravity

Lecture 8 - Impact of Gravity

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Lecture 10 - Curvilinear Motion Concept

Lecture 11 - Constant Pitch Rate Solution

Lecture 12 - Constant Velocity Solution

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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

Lecture 21 - Approximate Staging Solution

Lecture 22 - Variant Concept

Lecture 23 - Variant Design Solution

Lecture 24 - Parallel Staging Concept

Lecture 25 - Parallel Staging Benefits

Lecture 26 - Jet Damping and Ballistic Missiles

Lecture 27 - Current Rocket Concepts

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Lecture 6 - Applications of Airships

Lecture 7 - Tethered Aerostat systems

Lecture 8 - Why use Aerostats

Lecture 9 - Some Queries on Aerostats

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Lecture 19 - Indoor Blimp Projects by students

Lecture 20 - Biomimetic Airships

Lecture 21 - Introduction to Buoyancy

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Lecture 23 - Ballasting, Weigh off and Fuel weight recovery

Lecture 24 - In flight Ballast Collection methods

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Lecture 34 - Net Static Lift for other LTA systems

Lecture 35 - Tutorial Problem 4 on Net Static Lift Estimation

Lecture 36 - Parameters affecting Static Lift

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Lecture 41 - Effect of Slow change in Atmospheric Temperature and Superheat

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Lecture 59 - Pressure Height for other LTA Vehicles

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- Lecture 66 - Need for Ground Handling
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- Lecture 72 - Overview of Airship Design Methodology ADM
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- Lecture 83 - Sizing Procedure for Indoor Remotely Controlled Airships - Part 1
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NPTEL : NOC:Elements of Mechanical Vibration (Aerospace Engineering)

Co-ordinators : Prof. Ashish K Darpe

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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

Lecture 1 - Instability and Transition of Fluid Flows

Lecture 2 - Instability and Transition of Fluid Flows

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Lecture 1 - Introduction to Helicopter Aerodynamics and Dynamics

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Lecture 4 - Introduction to Helicopter Aerodynamics and Dynamics

Lecture 5 - Introduction to Helicopter Aerodynamics and Dynamics

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Lecture 7 - Introduction to Helicopter Aerodynamics and Dynamics

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Lecture 21 - Introduction to Helicopter Aerodynamics and Dynamics

Lecture 22 - Introduction to Helicopter Aerodynamics and Dynamics

Lecture 23 - Introduction to Helicopter Aerodynamics and Dynamics

Lecture 24 - Introduction to Helicopter Aerodynamics and Dynamics

Lecture 25 - Introduction to Helicopter Aerodynamics and Dynamics

Lecture 26 - Introduction to Helicopter Aerodynamics and Dynamics

NPTEL : Introduction to Propulsion (Aerospace Engineering)

Co-ordinators : Dr. D.P. Mishra

- Lecture 1 - Fundamentals of Aerospace Propulsion
- Lecture 2 - Fundamentals of Aerospace Propulsion
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NPTEL : Jet and Rocket Propulsion (Aerospace Engineering)

Co-ordinators : Dr. A. Kushari

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Lecture 1 - General Introduction: Airplane Performance Characteristics

Lecture 2 - George Cayley: Concept of Lift and Drag

Lecture 3 - Introduction to airplane and its components

Lecture 4 - Hansa 3 Aircraft and its Primary Systems

Lecture 5 - Concept of Lift Aerofoil: Wing : Complete Aircraft

Lecture 6 - Drag Polar

Lecture 7 - Revision

Lecture 8 - Standard Atmosphere: Description and Modeling

Lecture 9 - Measuring Instruments: Altimeter, Airspeed Indicator

Lecture 10 - Equations of Motion: Static Performance

Lecture 11 - Thrust Required, Power Required: Cruise

Lecture 12 - Excess Thrust and Power: Climb Angle and Rate of Climb

Lecture 13 - Review

Lecture 14 - Thrust Required: A Closer Look

Lecture 15 - Modeling of CL: Dimensional Analysis

Lecture 16 - A Closer Look: Point Mass Model, Dimensional Analysis

Lecture 17 - Estimation of Drag Polar Through Flight Test

Lecture 18 - Estimation of Rate of Climb

Lecture 19 - Revision.

Lecture 20 - Range and Endurance

Lecture 21 - Range and Endurance: (Continued...)

Lecture 22 - Gliding Flight

Lecture 23 - Accelerated Flight

Lecture 24 - V-n Diagram

Lecture 25 - Revision..

Lecture 26 - V stall: Cruise and Manoeuvre

Lecture 27 - Flaps:High Lift Devices to Reduce Take off / Landing Distance

Lecture 28 - Take off

Lecture 29 - Take off Performance

Lecture 30 - Take off Performance: (Continued...)

Lecture 31 - Revision...

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[Lecture 33 - Landing Performance: \(Continued...\)](#)

[Lecture 34 - Challenges in Takeoff and Landing: Single and Twin Engines](#)

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[Lecture 40 - Longitudinal Control: Elevator](#)

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[Lecture 42 - Stability: Wing and Tail Contribution](#)

[Lecture 43 - Control: Elevator](#)

[Lecture 44 - Control: Delta-e Required](#)

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[Lecture 46 - Design Basics: Wing Loading & Thrust Loading](#)

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[Lecture 48 - Revision.](#)

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Lecture 2 - Introduction to Static Stability

Lecture 3 - Stability and Trim

Lecture 4 - Stability : Wing Contribution

Lecture 5 - Stability : Tail Contribution and Static Margin

Lecture 6 - Problems : Stability and Wing Contribution Completed

Lecture 7 - Problems : Stability Tail Contribution Completed

Lecture 8 - Neutral Point and Fuselage Contribution Completed

Lecture 9 - Longitudinal Control Completed

Lecture 10 - Longitudinal Control (Continued...)

Lecture 11 - Control: Elevator

Lecture 12 - $C_{L_{trim}}$ Vs e_{trim}

Lecture 13 - Neutral Point: A Closer Look

Lecture 14 - Contribution of Engine towards Stability

Lecture 15 - Revision

Lecture 16 - Trim: Cruise, Climb and Landing

Lecture 17 - Trim: Maneuver

Lecture 18 - Maneuvering Point: Stick Fixed

Lecture 19 - Numerical: Stick Fixed Maneuvering Point and Flight Demonstration

Lecture 20 - Revision

Lecture 21 - Directional Stability

Lecture 22 - Directional Control

Lecture 23 - Lateral Stability and Control

Lecture 24 - Numericals : Directional, Lateral Stability and Control

Lecture 25 - Revision

Lecture 26 - Stick Free Stability

Lecture 27 - Stick Free Stability (Continued...)

Lecture 28 - Hinge Moment and Hinge Moment Derivative

Lecture 29 - Aircraft Handling Qualities

Lecture 30 - Aircraft Handling Qualities (Continued...)

Lecture 31 - Reversible Control: Stick Free and Trim Tabs

- Lecture 32 - Numericals: Stick Free
- Lecture 33 - Numericals: Stick Free (Continued...)
- Lecture 34 - Handling Qualities: Maneuvering Flight
- Lecture 35 - Determination of Neutral Point and Maneuvering Point by Flight Experiment
- Lecture 36 - Point Mass Equation of Motion
- Lecture 37 - Forces and Moments
- Lecture 38 - Aircraft Equations of Motion
- Lecture 39 - Six Degrees of Freedom of an Aircraft
- Lecture 40 - 6 DoF : Angular Momentum Components
- Lecture 41 - Vector in a Rotating Frame
- Lecture 42 - Euler Angles
- Lecture 43 - Small Perturbation Theory
- Lecture 44 - Small Perturbation Theory (Continued...)
- Lecture 45 - Perturbed Equations of Motion: Longitudinal Case
- Lecture 46 - Perturbed Force : f_z
- Lecture 47 - Perturbed Force : f_z (Continued...)
- Lecture 48 - Perturbed Pitching Moment
- Lecture 49 - Longitudinal Dimensional Stability Derivatives
- Lecture 50 - Dynamic Stability
- Lecture 51 - Longitudinal Modes
- Lecture 52 - Short Period and Phugoid Approximations
- Lecture 53 - Pure Pitching Motion
- Lecture 54 - Stability Augmentation System (SAS)
- Lecture 55 - Lateral-Directional Motion
- Lecture 56 - Tutorial - 1
- Lecture 57 - Tutorial - 2
- Lecture 58 - Tutorial - 3
- Lecture 59 - Tutorial - 4
- Lecture 60 - History of Aviation

- Lecture 1 - Thermodynamics and its Applications
- Lecture 2 - System and its Surroundings
- Lecture 3 - Property of System
- Lecture 4 - Energy and its Various Forms
- Lecture 5 - Concepts of Equilibrium and its State
- Lecture 6 - Energy and its Interactions
- Lecture 7 - Heat Interactions
- Lecture 8 - Thermodynamic Properties of Fluids - 1
- Lecture 9 - Thermodynamic Properties of Fluids - 2
- Lecture 10 - Thermodynamic Properties of Fluids - 3
- Lecture 11 - Thermodynamic Properties of Fluids - 4
- Lecture 12 - Thermodynamic Properties of Fluids - 5
- Lecture 13 - First Law of Thermodynamics for Cyclic Process
- Lecture 14 - First Law of Thermodynamics for Non-cyclic Process - 1
- Lecture 15 - First Law of Thermodynamics for Non-cyclic Process - 2
- Lecture 16 - Control Mass and Control Volume
- Lecture 17 - First Law of Thermodynamics for Steady Flow Processes
- Lecture 18 - First Law of Thermodynamics for Unsteady Flow Processes
- Lecture 19 - First Law of Thermodynamics to Reacting Systems
- Lecture 20 - Second Law of Thermodynamics: Basic Concepts - 1
- Lecture 21 - Second Law of Thermodynamics: Basic Concepts - 2
- Lecture 22 - Second Law of Thermodynamics: Carnot Cycle and Efficiency
- Lecture 23 - Second Law of Thermodynamics: Clausius Inequality
- Lecture 24 - Applications of Second Law of Thermodynamics: Entropy - 1
- Lecture 25 - Applications of Second Law of Thermodynamics: Entropy - 2
- Lecture 26 - Exergy
- Lecture 27 - Gas Turbine Cycle
- Lecture 28 - Vapor Power Cycle - 1
- Lecture 29 - Vapor Power Cycle - 2
- Lecture 30 - Vapor Power Cycle - 3
- Lecture 31 - Gas Power Cycles - 1

[Lecture 32 - Gas Power Cycles - 2](#)

[Lecture 33 - Refrigeration Cycles](#)

[Lecture 34 - Non-Reacting Mixture and Psychrometry](#)

[Lecture 35 - Gas-Vapor Mixture and Air Conditioning - 1](#)

[Lecture 36 - Gas-Vapor Mixture and Air Conditioning - 2](#)

[Lecture 37 - Thermodynamic Property Relations - 1](#)

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- Lecture 1 - Introduction to Dynamic Stability
- Lecture 2 - Spring-Mass-Damper System : Underdamped
- Lecture 3 - Spring-Mass-Damper System : Over and Critically damped
- Lecture 4 - Laplace Transform
- Lecture 5 - Pitch Dynamics : 1 D
- Lecture 6 - Numericals: Week - 1
- Lecture 7 - Aircraft Rigid Body Equation of Motion
- Lecture 8 - Six Degree of Freedom Equation of Motion
- Lecture 9 - Vector in Rotating Frame
- Lecture 10 - Forces and Moments on Aircraft
- Lecture 11 - Euler Angles
- Lecture 12 - Trajectory of the Aircraft
- Lecture 13 - Small Perturbation Theory
- Lecture 14 - Perturbed Aerodynamic Forces and Moments
- Lecture 15 - U-derivatives
- Lecture 16 - Alpha - derivatives
- Lecture 17 - Alpha Dot Derivatives
- Lecture 18 - q and delta Derivatives
- Lecture 19 - Dimensional Stability Derivatives
- Lecture 20 - Longitudinal Characteristic Equation
- Lecture 21 - Routh's Criteria and Longitudinal Dynamic Stability
- Lecture 22 - Longitudinal Modes: Short Period and Phugoid
- Lecture 23 - Short period Mode Approximation
- Lecture 24 - Long Period Mode (Phugoid) Approximation
- Lecture 25 - Lateral Directional Stability Derivatives
- Lecture 26 - Lateral Directional Stability Derivatives (Continued...)
- Lecture 27 - Perturbed Equation of Motion for Lateral Dynamics
- Lecture 28 - Modes of Lateral Directional Dynamics
- Lecture 29 - Spiral and Dutch Roll modes Approximation
- Lecture 30 - Routh-Hurwitz Stability Criterion
- Lecture 31 - Introduction to Stability Augmentation

[Lecture 32 - Pure Yawing and Pure Rolling Motion](#)

[Lecture 33 - SAS for Longitudinal Dynamics](#)

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[Lecture 35 - Flight Handling Qualities](#)

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[Lecture 38 - Mode Shape : Longitudinal Case](#)

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[Lecture 40 - Numericals : Transfer Functions and Response](#)

[Lecture 41 - Stability Augmentation System](#)

[Lecture 42 - Numericals : SAS](#)

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Lecture 1 - Introduction to Ancient Indian Civilization

Lecture 2 - Ancient Indian Civilization's Gift to the World

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

Lecture 9 - Introduction to Indian Agriculture

Lecture 10 - Problems arising due to modern agricultural practices

Lecture 11 - Pesticides and soil degradation

Lecture 12 - Agriculture - A Primary Productive Activity

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

Lecture 23 - Indus Valley and Harappan Civilization

Lecture 24 - First and Second of Indian Civilization

Lecture 25 - Town topologies and Brick and Tile making process

Lecture 26 - Availability of Water and Freshwater

Lecture 27 - Ancient Indian Wells

Lecture 28 - Temple Water tanks and Dams

Lecture 29 - Tank Irrigation system and Rainwater Harvesting

Lecture 30 - Waterbodies - Lakes and Canals

Lecture 31 - Sluices and Embankments

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[Lecture 34 - History of Copper](#)

[Lecture 35 - Iron during Vedic period](#)

[Lecture 36 - Iron smelting process in ancient India](#)

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[Lecture 38 - Extraction and smelting of Zinc in Ancient India](#)

[Lecture 39 - Metal Casting in Ancient India](#)

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- Lecture 1 - Weighment and Calculation of CG (Theory)
- Lecture 2 - Cruise Experiment (Theory)
- Lecture 3 - Weighment Experiment and cockpit panel description
- Lecture 4 - Drag Polar Experiment
- Lecture 5 - CG and Climb Experiment
- Lecture 6 - Calibration of Control Surface
- Lecture 7 - Calibration of Control Surfaces (Experiment)
- Lecture 8 - Introduction to Flight Data Recorder
- Lecture 9 - Sensors - Part I
- Lecture 10 - Sensors - Part II
- Lecture 11 - Data Acquisition using MEMS devices
- Lecture 12 - Estimation of Stick-Fixed Neutral Point
- Lecture 13 - Estimation of Stick-Free Neutral Point and Stick-Free Maneuvering Point
- Lecture 14 - Static: Lateral-Directional Stability Test
- Lecture 15 - Static: Lateral-Directional Stability Test (Continued...)
- Lecture 16 - Steady Coordinated Turn
- Lecture 17 - Introduction to Parameter Estimation
- Lecture 18 - Parameter Estimation using Least Squares Method
- Lecture 19 - Aerodynamic Parameter Estimation using Least Squares Method
- Lecture 20 - Aerodynamic Parameter Estimation using Delta Method
- Lecture 21 - Aerodynamic Parameter Estimation using Delta Method (Continued...)

- Lecture 1 - Fundamental laws of nature, system definitions and applications
- 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

Lecture 41 - Exergy balance and second law efficiency for closed systems and steady flow devices

Lecture 42 - Examples related to exergy change and exergy destruction

Lecture 43 - Gas power cycles and air-standard assumptions

Lecture 44 - An overview of reciprocating engines and otto cycle

Lecture 45 - Analysis of Diesel cycle

Lecture 46 - Analysis of Brayton cycle

Lecture 47 - Examples on gas power cycles such as Otto, Diesel and Brayton

Lecture 48 - Rankin and Carnot vapour power cycles

Lecture 49 - Ideal regenerative Rankin cycle and combined gas-vapour cycle

Lecture 50 - Refrigeration cycles

Lecture 51 - Examples on vapour power cycles

Lecture 52 - Thermodynamic property relations: Gibbs equation, Mnemonic diagrams and reciprocity relations

Lecture 53 - hermodynamic property relations: Clapeyron equation and Maxwell relations

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

Lecture 55 - Combustion and conservation of mass in a chemical reaction

Lecture 56 - Energy balance for reacting systems

Lecture 57 - Enthalpy of formation and combustion, adiabatic flame temperature

Lecture 58 - Examples on property relations and reaction thermodynamics

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Lecture 2 - Wing Loading and Thrust Loading

Lecture 3 - Basic Design - Lift and Drag

Lecture 4 - Range and Endurance

Lecture 5 - Mission Requirements

Lecture 6 - Range and Endurance : Propeller-driven Aircraft

Lecture 7 - Fuel Consumption : Cruise Flight

Lecture 8 - L/D for Maximum Range and Endurance

Lecture 9 - Range and endurance for Jet-driven Aircraft

Lecture 10 - Estimation of Fuel for a Mission

Lecture 11 - Design Considerations : Power Plant, Gross Weight

Lecture 12 - Design Considerations : Aerofoil Selection

Lecture 13 - Design Considerations : Wing

Lecture 14 - Wing Design: Aerofoil

Lecture 15 - Wing Design:t/c, Camber and Leading Edge Radius

Lecture 16 - Wing Design: Aspect Ratio

Lecture 17 - Wing Design: Sweep, Twist and Taper Ratio

Lecture 18 - Wing Arrangements

Lecture 19 - Tail Arrangements

Lecture 20 - Tail Arrangements (Continued...)

Lecture 21 - Aircraft Structure

Lecture 22 - Wing Loading and Power Loading

Lecture 23 - Thrust Loading and Wing Loading

Lecture 24 - Thrust Loading

Lecture 25 - Wing Loading

Lecture 26 - Wing Loading : Maneuver, Climb and glide

Lecture 27 - Take off: Wing Loading and Thrust Loading

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

Lecture 29 - Wing Loading: Take off and Landing

Lecture 30 - Revision (Wing Loading and Thrust Loading)

Lecture 31 - Numerical: Wing Loading

[Lecture 32 - Wing Loading: Designers Approach](#)

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[Lecture 34 - Static Stability Basics](#)

[Lecture 35 - Wing and tail contribution to Longitudinal Static Stability](#)

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[Lecture 37 - Conceptual design \(Continued...\)](#)

[Lecture 38 - Elevator Effectiveness](#)

[Lecture 39 - Elevator Effectiveness \(Continued...\)](#)

[Lecture 40 - Numerical - Pitching moment](#)

[Lecture 41 - Numerical - Elevator Effectiveness](#)

[Lecture 42 - Aircraft Maintenance Guidelines](#)

[Lecture 43 - Inspection for Aircraft](#)

[Lecture 44 - Numerical of Weight Fraction](#)

[Lecture 45 - Inspection of Sinus 912 Motor Glider](#)

[Lecture 46 - Numericals](#)

- Lecture 1 - Introduction to fundamentals of combustion
- Lecture 2 - Scope and applications of combustion
- Lecture 3 - Scope of combustion (Continued...) and types of fuel and oxidizers
- Lecture 4 - Characterization of liquid and gaseous fuel
- Lecture 5 - Properties of liquid and solid fuels, various modes of combustion
- Lecture 6 - Thermodynamics of combustion
- Lecture 7 - Thermodynamics of combustion (Continued...)
- Lecture 8 - Laws of thermodynamics and Stoichiometry
- Lecture 9 - Stoichiometric calculations for air-gas mixture
- Lecture 10 - Mixture fraction calculation for diffusion flames
- Lecture 11 - Thermochemistry
- Lecture 12 - Heat of reaction and bond energy
- Lecture 13 - Adiabatic flame temperature
- Lecture 14 - Adiabatic flame temperature and its effect on various parameters
- Lecture 15 - Introduction to chemical equilibrium
- Lecture 16 - Chemical equilibrium and Gibbs free energy
- Lecture 17 - Equilibrium constants and Le chatlier principle
- Lecture 18 - Determination of chemical equilibrium composition
- Lecture 19 - Chemical and reaction kinetics
- Lecture 20 - Compact notation and reaction rate of chemical reaction
- Lecture 21 - Collision Theory
- Lecture 22 - Collision theory (Continued...)
- Lecture 23 - Collision frequency of molecules
- Lecture 24 - Specific reaction rate and Arrhenius law
- Lecture 25 - First order, Second order and Third-order reactions
- Lecture 26 - Classification of chemical reactions
- Lecture 27 - Elementary chain reactions
- Lecture 28 - Quasi-steady state and partial equilibrium approximation
- Lecture 29 - Physics of combustion
- Lecture 30 - Transport equations and molecular model for transport process
- Lecture 31 - Mean free path length

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[Lecture 33 - Lennard-Jones potential model \(Continued...\)](#)

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[Lecture 35 - Momentum conservation equation](#)

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[Lecture 37 - Species transport equation](#)

[Lecture 38 - Energy conservation equation](#)

[Lecture 39 - Conserved scalar approach for one dimensional flows](#)

[Lecture 40 - Introduction to turbulent combustion](#)

Lecture 1 - Rules and Regulations for Civil Aviation in India

Lecture 2 - Rules and Regulations for Civil Aviation in India (Continued...)

Lecture 3 - Aircraft Hydraulic System

Lecture 4 - Aircraft Fuel System

Lecture 5 - Aircraft Landing Gear System

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Lecture 39 - Computing aerodynamic flows - trying to connect with the theory

Lecture 40 - Computing aerodynamic flows - trying to connect with the theory (Continued...)

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Lecture 43 - Panel method and Vortex Lattice Method

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Lecture 62 - Strain gauge based balances; Electronic pressure gauges

Lecture 63 - Absolute-Gauge-Differential pressure sensors; Data Acquisition System

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NPTEL : NOC:Smart Structures (Aerospace Engineering)

Co-ordinators : Prof. Mohammed Rabius Sunny

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NPTEL : Acoustic Instabilities in Aerospace Propulsion (Aerospace Engineering)

Co-ordinators : Prof. R.I. Sujith

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- Lecture 11 - Attenuation : Continued Sound Propagation Through Inhomogeneous Media - 1
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Lecture 9 - General Performance Parameters II

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- [Lecture 41 - Hybrid Rocket Combustion](#)
- [Lecture 42 - Chemical Equilibrium Analyser - SP 273](#)

NPTEL : Combustion (Aerospace Engineering)

Co-ordinators : Prof. S.R. Chakravarthy

Lecture 1 - Introduction

Lecture 2 - Chemical Reactions, Heats of Reaction and Formation

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

Lecture 7 - Equilibrium Reactions, Global Kinetics, Order of Reaction

Lecture 8 - Reduced Chemistry, Steady State Approximation

Lecture 9 - Steady State Approximation, Partial Equilibrium Approximation

Lecture 10 - Partial Equilibrium Approximation, Chemical Explosions

Lecture 11 - Combining Chemical and Thermal Processes 1

Lecture 12 - Combining Chemical and Thermal Processes 2

Lecture 13 - Combining Chemical and Thermal Processes 3

Lecture 14 - Combining Chemical and Thermal Processes 4

Lecture 15 - Mass and Molar Diffusion, Fick's Law

Lecture 16 - Conservation Equations for Multi-Component Mixtures

Lecture 17 - Multi-Component Diffusion Equation

Lecture 18 - Multi-Component Momentum Equation

Lecture 19 - Energy Equation

Lecture 20 - One Dimensional Steady Flow

Lecture 21 - Schvab-Zeldovich Formulation 1

Lecture 22 - Schvab-Zeldovich Formulation 2

Lecture 23 - Rankine-Hugoniot Relations 1

Lecture 24 - Rankine-Hugoniot Relations 2

Lecture 25 - Rankine-Hugoniot Relations 3

Lecture 26 - Velocity, Temperature and Entropy Variation along Hugoniot Curve

Lecture 27 - Laminar Premixed Flames

Lecture 28 - Laminar Premixed Flames - Corrections

Lecture 29 - Laminar Premixed Flames - Rigorous Analysis 1

Lecture 30 - Laminar Premixed Flames - Rigorous Analysis 2

Lecture 31 - Flame Speed Dependencies, G-Equation

[Lecture 32 - Bunsen Burner 1](#)

[Lecture 33 - Bunsen Burner 2](#)

[Lecture 34 - Flame Stabilisation 1](#)

[Lecture 35 - Flame Stabilisation 2](#)

[Lecture 36 - Ignition](#)

[Lecture 37 - Burke-Schumann Problem 1](#)

[Lecture 38 - Burke-Schumann Problem 2](#)

[Lecture 39 - Burke-Schumann Problem 3](#)

[Lecture 40 - Flame Structure](#)

[Lecture 41 - Mixture Fraction Formulation 1](#)

[Lecture 42 - Mixture Fraction Formulation 2](#)

[Lecture 43 - Droplet Burning 1](#)

[Lecture 44 - Droplet Burning 2](#)

[Lecture 45 - Spray Combustion 1](#)

[Lecture 46 - Spray Combustion 2](#)

[Lecture 47 - Turbulent Combustion 1](#)

[Lecture 48 - Turbulent Combustion 2](#)

[Lecture 49 - Combustion Instabilities](#)

[Lecture 50 - Detonations](#)

[Lecture 51 - Detonation Wave - ZND Structure](#)

- Lecture 1 - Earth Atmosphere, Aircraft components, Aircraft nomenclature
- Lecture 2 - Basic aerodynamics
- 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
- Lecture 10 - Powerplant contribution
- Lecture 11 - Power effects on neutral point
- Lecture 12 - Elevator
- Lecture 13 - Stick free stability, Most fwd CG location
- Lecture 14 - Longitudinal stick force per 'g', Ground effect
- 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](#)

[Lecture 39 - Wind Profiles, Longitudinal Mode Response to Wind Shear](#)

[Lecture 40 - Stability control/Augmentation](#)

[Lecture 41 - Autopilots, Automatic Landing System](#)

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

- Lecture 1 - Introduction, Why and how we need computers
- 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
- Lecture 29 - Flux Vector Splitting, setup froms averaging
- Lecture 30 - Roes averaging
- Lecture 31 - Demo - One Dimensional flow

[Lecture 32 - Accelerating convergence - Preconditioning, dual time stepping](#)

[Lecture 33 - Accelerating convergence - Intro to Multigrid method](#)

[Lecture 34 - Multigrid method](#)

[Lecture 35 - Multigrid method - final, Parallel Computing](#)

[Lecture 36 - Calculus of Variations - Three Lemmas and a Theorem](#)

[Lecture 37 - Calculus of Variations - Application to Laplace Equation](#)

[Lecture 38 - Calculus of Variations - Final and Random Walk](#)

[Lecture 39 - Overview and Recap of the course](#)

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Lecture 2 - Motion in Space

Lecture 3 - Rotational Frame of Reference and Orbital Velocities

Lecture 4 - Velocity Requirements

Lecture 5 - Theory of rocket propulsion

Lecture 6 - Rocket Equation and Staging of Rockets

Lecture 7 - Review of Rocket Principles: Propulsion Efficiency

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

Lecture 9 - Theory of Nozzles

Lecture 10 - Nozzle Shape

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

Lecture 12 - Characteristic Velocity and Thrust Coefficient

Lecture 13 - Divergence Loss in Conical Nozzles and the Bell Nozzles

Lecture 14 - Unconventional Nozzles and Problems in Nozzles

Lecture 15 - Criterion for Choice of Chemical Propellants

Lecture 16 - Choice of Fuel-Rich Propellants

Lecture 17 - Performance Prediction Analysis

Lecture 18 - Factors Influencing Choice of Chemical Propellants

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

Lecture 20 - Introduction to Solid Propellant Rockets

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

Lecture 22 - Design Aspects of Solid Propellant Rockets

Lecture 23 - Burning Surface Area of Solid Propellant Grains

Lecture 24 - Ignition of Solid Propellant Rockets

Lecture 25 - Review of Solid Propellant Rockets

Lecture 26 - Feed Systems for Liquid Propellant Rockets

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

Lecture 28 - Analysis of Gas Generator and Staged combustion cycles and introduction to injectors

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

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

Lecture 31 - Pumps and Turbines: Propellant Feed System at Zero -g- Conditions

[Lecture 32 - Review of Liquid Bi-propellant Rockets and Introduction to Mono-propellant Rockets](#)

[Lecture 33 - Introduction to Hybrid Rockets and a Simple Illustration of Combustion instability in Liquid Propellant Rockets](#)

[Lecture 34 - Principles of Electrostatic and Electromagnetic Rockets](#)

[Lecture 35 - Electrical Thrusters](#)

[Lecture 36 - Electrical and Nuclear Rockets; Advanced Propulsion](#)

- Lecture 1 - Introduction and Motivation for Advanced Control Design
- Lecture 2 - Classical Control Overview - I
- Lecture 3 - Classical Control Overview - II
- Lecture 4 - Classical Control Overview - III
- Lecture 5 - Classical Control Overview - IV
- Lecture 6 - Basic Principles of Atmospheric Flight Mechanics
- Lecture 7 - Overview of Flight Dynamics - I
- Lecture 8 - Overview of Flight Dynamics - II
- Lecture 9 - Representation of Dynamical Systems - I
- Lecture 10 - Representation of Dynamical Systems - II
- Lecture 11 - Representation of Dynamical Systems - III
- Lecture 12 - Review of Matrix Theory - I
- Lecture 13 - Review of Matrix Theory - II
- Lecture 14 - Review of Matrix Theory - III
- Lecture 15 - Review of Numerical Methods
- Lecture 16 - Linearization of Nonlinear Systems
- Lecture 17 - First and Second Order Linear Differential Equations
- Lecture 18 - Time Response of Linear Dynamical Systems
- Lecture 19 - Stability of Linear Time Invariant Systems
- Lecture 20 - Controllability and Observability of linear Time Invariant Systems
- Lecture 21 - Pole Placement Control Design
- Lecture 22 - Pole Placement Observer Design
- Lecture 23 - Static Optimization: An Overview
- Lecture 24 - Calculus of Variations: An Overview
- Lecture 25 - Optimal Control Formulation using Calculus of Variations
- Lecture 26 - Classical Numerical Methods for Optimal Control
- Lecture 27 - Linear Quadratic Regulator (LQR) Design - 1
- Lecture 28 - Linear Quadratic Regulator (LQR) Design - 2
- Lecture 29 - Linear Control Design Techniques in Aircraft Control - I
- Lecture 30 - Linear Control Design Techniques in Aircraft Control - II
- Lecture 31 - Lyapunov Theory - I

[Lecture 32 - Lyapunov Theory - II](#)

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[Lecture 34 - Dynamic Inversion - I](#)

[Lecture 35 - Dynamic Inversion - II](#)

[Lecture 36 - Neuro-Adaptive Design - I](#)

[Lecture 37 - Neuro-Adaptive Design - II](#)

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[Lecture 40 - An Overview of Kalman Filter Theory](#)

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Lecture 2 - Overview of SS Approach and Matrix Theory

Lecture 3 - Review of Numerical Methods

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Lecture 5 - An Overview of Static Optimization - II

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Lecture 7 - Review of Calculus of Variations - II

Lecture 8 - Optimal Control Formulation Using Calculus of Variations

Lecture 9 - Classical Numerical Methods to Solve Optimal Control Problems

Lecture 10 - Linear Quadratic Regulator (LQR) - I

Lecture 11 - Linear Quadratic Regulator (LQR) - II

Lecture 12 - Linear Quadratic Regulator (LQR) - III

Lecture 13 - Linear Quadratic Regulator (LQR) - III

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Lecture 15 - Overview of Flight Dynamics - I

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Lecture 17 - Overview of Flight Dynamics - III

Lecture 18 - Linear Optimal Missile Guidance using LQR

Lecture 19 - SDRE and \hat{I} , - D Designs

Lecture 20 - Dynamic Programming

Lecture 21 - Approximate Dynamic Programming (ADP), Adaptive Critic (AC) and Single Network Adaptive Critic (SNAC) Design

Lecture 22 - Transcription Method to Solve Optimal Control Problems

Lecture 23 - Model Predictive Static Programming (MPSP) and Optimal Guidance of Aerospace Vehicles

Lecture 24 - MPSP for Optimal Missile Guidance

Lecture 25 - Model Predictive Spread Control (MPSC) and Generalized MPSP (G-MPSP) Designs

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Lecture 27 - Review of Probability Theory and Random Variables

Lecture 28 - Kalman Filter Design - I

Lecture 29 - Kalman Filter Design - II

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Lecture 31 - Integrated Estimation, Guidance & Control - I

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[Lecture 33 - LQG Design; Neighboring Optimal Control & Sufficiency Condition](#)

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[Lecture 35 - Constrained Optimal Control - II](#)

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[Lecture 37 - Optimal Control of Distributed Parameter Systems - I](#)

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[Lecture 39 - Take Home Material: Summary - I](#)

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Lecture 3 - Chemical Equilibrium - II

Lecture 4 - Chemical Kinetics - I

Lecture 5 - Chemical Kinetics - II

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Lecture 8 - Oxidation Mechanism of Fuels - I

Lecture 9 - Oxidation Mechanism of Fuels - II

Lecture 10 - Oxidation Mechanism of Fuels - III

Lecture 11 - Oxidation Mechanism of Fuels - IV

Lecture 12 - Transport Phenomena

Lecture 13 - Governing Equations - I

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Lecture 15 - Governing Equations - III

Lecture 16 - Governing Equations - IV

Lecture 17 - Governing Equations - V

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Lecture 20 - Laminar Non-Premixed Flames - III

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Lecture 49 - Aero Gas Turbine Combustors - II
Lecture 50 - Aero Gas Turbine Combustors - III
Lecture 51 - Aero Gas Turbine Combustors - IV
Lecture 52 - Aero Gas Turbine Combustors - V
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Lecture 54 - Flame Stabilization and Blow off - II
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Lecture 11 - Stagnation properties

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Lecture 22 - Waves of infinitesimal Amplitude

Lecture 23 - Waves of finite amplitude

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Lecture 25 - Unsteady Flows - Numerical

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- Lecture 32 - Varying Area Duct Flows - II
- Lecture 33 - Converging Nozzle and Chocking
- Lecture 34 - Converging and Diverging Nozzle Operation
- Lecture 35 - Varying area flow- Numericals - I
- Lecture 36 - Diffusers Intakes/Inlets
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- Lecture 54 - Method of Characteristics: Applications
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- Lecture 60 - Concluding Remarks