

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 Turboshaft 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](#)

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

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

[Lecture 36 - Tutorial 6 : Radial Turbines](#)

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

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

[Lecture 39 - CFD for Turbomachinery: Flow Track and Inter-spool Duct Design using CFD](#)

[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

[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](#)

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

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[Lecture 48 - Turning Flight Equations](#)

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[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](#)

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[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](#)

[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

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
- Lecture 50 - Subsonic Parasite Drag Estimation
- 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 75 - Range Payload Diagram - Part 1](#)
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- [Lecture 77 - Tutorial on Range Payload Diagram of Transport Aircraft](#)
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- [Lecture 82 - Tutorial on V-n Diagram of Transport Aircraft](#)
- [Lecture 83 - High Altitude Long Endurance \(HALE\) Aircraft](#)
- [Lecture 84 - Morphing of Aircraft Configurations](#)
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- [Lecture 86 - Guest Lecture on Air Power and Multi-role Fighter Aircraft - Part 2](#)

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Lecture 2 - Course Plan

Lecture 3 - Ascent Mission Basics

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Lecture 5 - Force and Geometry Models - 2

Lecture 6 - Idealized Performance

Lecture 7 - Trajectory Under Gravity

Lecture 8 - Impact of Gravity

Lecture 9 - Impact of Drag

Lecture 10 - Curvilinear Motion Concept

Lecture 11 - Constant Pitch Rate Solution

Lecture 12 - Constant Velocity Solution

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

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

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Lecture 28 - Launch Widow and SSTO Concepts

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Lecture 3 - The three conventional LTA systems

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Lecture 5 - Introduction of Skyship 600 and USP of Airships

Lecture 6 - Applications of Airships

Lecture 7 - Tethered Aerostat systems

Lecture 8 - Why use Aerostats

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Lecture 31 - Effect of Lifting Gas Purity, Superpressure and Superheat

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Lecture 34 - Net Static Lift for other LTA systems

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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

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NPTEL : Introduction to Propulsion (Aerospace Engineering)

Co-ordinators : Dr. D.P. Mishra

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NPTEL : Jet and Rocket Propulsion (Aerospace Engineering)

Co-ordinators : Dr. A. Kushari

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- Lecture 4 - Macroscopic and microscopic forms of energy
- Lecture 5 - Different forms of work, energy transfer and sign convention
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- Lecture 8 - Examples on basic concept and energy balance
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- 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
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- Lecture 21 - Conservation of mass and steady flow processes
- Lecture 22 - Flow work and energy of flowing fluid
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- Lecture 24 - Throttling valve, mixing chamber and heat exchanger
- Lecture 25 - Energy analysis of steady and unsteady flow devices
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- 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

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NPTEL : NOC:Space Environment and its Effects on Orbital Spacecrafts (Aerospace Engineering)

Co-ordinators : Prof. Soumyabrata Chakrabarty

- Lecture 1 - Space environment and its Types, Space Weather Definition, Anatomy of Sun, Solar Activities as Space Weather Driver
- Lecture 2 - Solar Activities, Solar Wind, Solar Flare, Coronal Mass Ejection and Solar Energetic Particles Event
- Lecture 3 - Interplanetary Magnetic Field (IMF), Co-rotating Interaction Regimes Corona, Coronal Structures, Coronal Loops, Helmet Streamers and Coronal Holes
- Lecture 4 - Interplanetary Magnetic Field (IMF), Co-rotating Interaction Regions
- Lecture 5 - Coupling of Solar Wind to Earth's Magnetosphere and Ionosphere, Geomagnetic Storm, Geomagnetic Substorm and Geomagnetic Indices
- Lecture 6 - Earth's Radiation Belt, Ring Current and South Atlantic Anomaly
- Lecture 7 - Satellite Orbits, Geometry, Velocity and Period, Orbital Parameters and Orbital Perturbations
- Lecture 8 - Different Types of Earth's Orbit for Useful Satellite Applications
- Lecture 9 - Satellite Segments, Space segments, Mechanical Main Frames, Structures and Thermal Control System
- Lecture 10 - Satellite Segments, Space segments, Mechanical Main Frames, Mechanisms, Propulsion System, Electrical Main Frame and Power System
- Lecture 11 - Satellite Segments, Space segments, Electrical Main Frame, TT and C, Attitude and Orbit Control System and Payloads
- Lecture 12 - Satellite Segments, Earth Segments, Receive-Only Earth Station, Transmit-Receive Earth Stations
- Lecture 13 - Characteristics of Vacuum Environment, The Effects on Spacecraft, Extreme Temperatures, Exposure to Radiation and Outgassing
- Lecture 14 - Vacuum Environment, Outgassing, Outgassing Mechanism and Transport of Outgassed Material
- Lecture 15 - Outgassing of Spacecraft Materials, TML, CVCM, WVR and Its Significance, Ground Simulation of Vacuum Environment, Thermo-Vacuum Chamber, Thermo-Vacuum Test Philosophy and Characterization of TML, CVCM and WVR
- Lecture 16 - Vacuum Environment, The Effect of Exposure of UV Radiation on Spacecraft Material, Design Guidelines and Mitigation Techniques
- Lecture 17 - Neutral Gas Flow Around a Spacecraft, Effects on Spacecraft, Atomic Oxygen Attack, Sputtering, Contamination and Spacecraft Glow
- Lecture 18 - Neutral Space Environment, Atmospheric Drag, Drag Force and Satellite Orbital Parameters
- Lecture 19 - Neutral Space Environment, The Micrometeoroid/Orbital Debris Particulate Environment and Hyper Velocity Particle Impact on Spacecraft
- Lecture 20 - Spacecraft Induced Neutral Environment, Scattering of Electromagnetic (EM) Radiation from Particles and Orbital debris
- Lecture 21 - Orbital Debris, Dealing with Space Debris- Management, International Cooperation, Monitoring, Detection and Tracking, Radar Techniques and Optical Techniques
- Lecture 22 - Capturing of Orbital debris, Contact capturing method, Contactless capturing method and Removal of Orbital debris
- Lecture 23 - Removal of Orbital debris, Space Environment based and Non-space Environment
- Lecture 24 - Removal of Orbital debris, Non-space Environment based methods and Mitigation strategies
- Lecture 25 - What is plasma and its nature, Behavior of plasma in external Electromagnetic field, Uniform magnetic field, Gyro-radius and Cyclotron frequency
- Lecture 26 - Charge particle movement in a uniform magnetic field, Helical particle trajectory, Guiding center, Pitch and pitch angle,

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Dimagnetic properties of plasma, Magnetic moment, $E \times B$ drift and Drift velocity

Lecture 27 - Introduction to Plasma, Magnetic moment, $E \times B$ drift, Plasma Oscillations and plasma frequency and Debye Shielding

Lecture 28 - Debye Shielding, External charge introduced in plasma, Debye length and Debye volume

Lecture 29 - Collective Behavior of plasma and Velocity, Energy, Temperature of plasma

Lecture 30 - Non-uniform magnetic field, Magnetic mirroring and Trapping of charged particles

Lecture 31 - Plasma environment in earth's orbit, Origin of space plasma in earth's orbit, Effects on spacecraft and Plasma environment at different earth's orbits

Lecture 32 - Spacecraft charging, Capacitor charging, Probe theory, Langmuir probe, Physics of Spacecraft charging and Spacecraft as a Langmuir probe

Lecture 33 - Spacecraft charging: probe theory, Langmuir probe, Langmuir probe equation for a sphere in the orbit-limited regime, Current Collection in Cylindrical Geometry and Current Collection in Plane Geometry

Lecture 34 - Spacecraft charging, Spacecraft Equilibrium Potential, Repelling of Like Charges, Attraction of Opposite Charges, Boltzmann's Repulsion Factor and Spacecraft Potential in Plasma

Lecture 35 - Spacecraft charging, Current balance equation, Current collection in spacecrafts and Different current components

Lecture 36 - Spacecraft charging, Different Plasma Fluxes Affecting Spacecraft, Charging and Current balance equation and spacecraft potential

Lecture 37 - Spacecraft charging, Lumped Circuit model of spacecraft, Different types of spacecraft charging and Effects of spacecraft charging

Lecture 38 - Spacecraft charging, Analysis, design, testing, inspection and Mitigation strategies

Lecture 39 - Numerical problems related to plasma physics

Lecture 40 - What is radiation, What is space radiation environment and its classifications and origin

Lecture 41 - Ionizing and non-ionizing Radiation, Ionizing radiation, Linear Energy Transfer, Total Ionizing dose, Stopping cross section and Stopping range

Lecture 42 - Radiation Energy: Classical Vs Relativistic, Bremsstrahlung Radiation, X- Rays, Gamma Rays, Photoelectric Effect, Compton Effect and Pair Production

Lecture 43 - Displacement damage and Total Radiation Dose

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Lecture 46 - Modelling, Simulation and Testing and Mitigation towards Space Radiation Risks

Lecture 47 - Ground Simulation of space environment and launch conditions, Test and Evaluation for Space qualification, Introduction of reliability and Reliability and Failure function

Lecture 48 - Reliability and Failure function, Failure probability density function and Failure or hazard rate

Lecture 49 - Significance of hazard or failure rate, Reliability in terms of failure or hazard rate and Failure rate and bathtub curve

Lecture 50 - Failure rate and bathtub curve, Gaussian and Weibull probability density function, Meantime to failure and Mean satellite lifetime

Lecture 51 - Mean satellite lifetime, Satellite System Availability, Without backup and With backup

Lecture 52 - Satellite System Availability, Without backup, With backup and System reliability

Lecture 53 - System reliability, Subsystems in series and Redundant Subsystems

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Lecture 54 - System reliability, Redundant Subsystems (static redundancy), MTTF, Failure rate, n- sub-systems in parallel and Reliability if k out of n elements are necessary

Lecture 55 - System reliability, Reliability if k out of n elements are necessary and Dynamic Redundant Subsystems (with switching)

Lecture 56 - System reliability, Dynamic redundancy (with switching), Generalized expression for system reliability with Dynamic redundancy using switching and Redundancy with different failure rates

Lecture 57 - Equipment redundancy taking account of the reliability of the switching element and Example: Redundancy of TWTs in the channelized part of a payload

Lecture 58 - Equipment having several failure modes, Component Reliability and Quality assurance

Lecture 59 - Component selection and Quality assurance

Lecture 60 - Component selection and Quality assurance

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Lecture 5 - Normal Shock Waves: Entropy and Irreversibility

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- Lecture 17 - Reference Books Derivation of Rayleigh Criteria
- Lecture 18 - Effect of Heat release on the Acoustic Field
- Lecture 19 - Modal Analysis of Thermoacoustic Instability - 1
- Lecture 20 - Modal Analysis of Thermoacoustic Instability - 2
- Lecture 21 - Active Control of Thermoacoustic Instability
- Lecture 22 - Toy model for a Rijke tube in Time Domain
- Lecture 23 - Galerkin Technique for Thermoacoustics
- Lecture 24 - Evolution Equation for Thermoacoustics
- Lecture 25 - Non linear analysis of Thermoacoustic Instability
- Lecture 26 - Non-normality, Transient Growth and Triggering Instability - 1
- Lecture 27 - Non-normality, Transient Growth and Triggering Instability - 2
- Lecture 28 - Non-normality, Transient Growth and Triggering Instability - 3
- Lecture 29 - Bifurcations
- Lecture 30 - Premixed Flame Acoustic Interaction - 1
- Lecture 31 - Premixed Flame Acoustic Interaction - 2

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[Lecture 33 - Role of Hydrodynamic Instabilities - 1](#)

[Lecture 34 - Role of Hydrodynamic Instabilities - 2](#)

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[Lecture 36 - Active Control of Thermoacoustic Instability Revisited](#)

[Lecture 37 - Solid Propellant Combustion Instability - 1](#)

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[Lecture 40 - Response of a Diffusion Flame to Acoustic Oscillations - 2](#)

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Lecture 3 - Air breathing Engines - Turbojet II

Lecture 4 - Air breathing Engines - Turboprop & Turbofan

Lecture 5 - Air breathing Engines - Ramjet & Scramjet

Lecture 6 - Non-air breathing Engines I

Lecture 7 - Non-air breathing Engines II

Lecture 8 - General Performance Parameters I

Lecture 9 - General Performance Parameters II

Lecture 10 - Cycle Analysis - Ramjet

Lecture 11 - Cycle Analysis - Turbojet I

Lecture 12 - Cycle Analysis - Turbojet II

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Lecture 17 - Cycle Analysis - Turbofan

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Lecture 19 - Rocket Nozzles - 1D Analysis II

Lecture 20 - Rocket Nozzles - 1D Analysis III

Lecture 21 - Rocket Nozzles - Real Effects I

Lecture 22 - Rocket Nozzles - Real Effects II

Lecture 23 - Rocket Nozzles - Thrust Vectoring

Lecture 24 - Solid Rockets - Propellants

Lecture 25 - Solid Rockets - Burn rate

Lecture 26 - Solid Rockets - Performance

Lecture 27 - Solid Rockets - Grain

Lecture 28 - Solid Rockets - Ignition, Quenching

Lecture 29 - Solid Rockets - Igniter, Depressurization

Lecture 30 - Propellant Combustion - Combustion Modelling

Lecture 31 - Liquid Rocket - Propellants

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[Lecture 33 - Liquid Rocket - Nozzle Cooling II](#)

[Lecture 34 - Liquid Rocket - Nozzle Cooling III](#)

[Lecture 35 - Liquid Rocket - Pressure fed system](#)

[Lecture 36 - Liquid Rocket - Pump fed system](#)

[Lecture 37 - Liquid Rocket - Pumps](#)

[Lecture 38 - Liquid Rocket - Fuel Injection](#)

[Lecture 39 - Hybrid Rocket - Basics](#)

[Lecture 40 - Hybrid Rocket Performance](#)

[Lecture 41 - Hybrid Rocket Combustion](#)

[Lecture 42 - Chemical Equilibrium Analyser - SP 273](#)

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

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

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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](#)

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[Lecture 34 - Flame Stabilisation 1](#)

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

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

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[Lecture 40 - Flame Structure](#)

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[Lecture 43 - Droplet Burning 1](#)

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[Lecture 45 - Spray Combustion 1](#)

[Lecture 46 - Spray Combustion 2](#)

[Lecture 47 - Turbulent Combustion 1](#)

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[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](#)

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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

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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

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Lecture 29 - Linear Control Design Techniques in Aircraft Control - I

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

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Lecture 2 - Overview of SS Approach and Matrix Theory

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Lecture 5 - An Overview of Static Optimization - II

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Lecture 7 - Review of Calculus of Variations - II

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Lecture 9 - Classical Numerical Methods to Solve Optimal Control Problems

Lecture 10 - Linear Quadratic Regulator (LQR) - I

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Lecture 12 - Linear Quadratic Regulator (LQR) - III

Lecture 13 - Linear Quadratic Regulator (LQR) - III

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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

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Lecture 3 - Chemical Equilibrium - II

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Lecture 8 - Oxidation Mechanism of Fuels - I

Lecture 9 - Oxidation Mechanism of Fuels - II

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Lecture 20 - Laminar Non-Premixed Flames - III

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Lecture 51 - Aero Gas Turbine Combustors - IV
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Lecture 11 - Stagnation properties

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- Lecture 33 - Converging Nozzle and Chocking
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- Lecture 36 - Diffusers Intakes/Inlets
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- Lecture 38 - Varying area flow - Numericals - II
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- Lecture 41 - 1D flow with friction - Fanno flow - I
- Lecture 42 - 1D flow with friction - Fanno flow - II
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- Lecture 45 - 1D Flows with Heat Addition: Rayleigh Flows - I
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- Lecture 48 - Generalized 1D Flows
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- Lecture 52 - Method of Characteristics: 2D Supersonic Flow - I
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- Lecture 54 - Method of Characteristics: Applications
- Lecture 55 - Hypersonic Flows - I
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- Lecture 57 - Edney Shock Interaction
- Lecture 58 - Shock Boundary Layer Interaction - I
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- Lecture 60 - Concluding Remarks

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- Lecture 3 - Tutorial 1: Vectors and coordinates
- Lecture 4 - Tutorial 2: Vectors and coordinate transformations
- Lecture 5 - Coordinate frames and transformations
- Lecture 6 - Rigid body transformations
- Lecture 7 - Dynamic model of multirotors
- Lecture 8 - Drone sensors
- Lecture 9 - Drone sensors - Context
- Lecture 10 - MATLAB demonstration - drone sensors
- Lecture 11 - Basics of Estimation
- Lecture 12 - Kalman filtering Technique
- Lecture 13 - Extended Kalman Filters (EKF)
- Lecture 14 - Matlab Demonstration of Kalman Filtering
- Lecture 15 - Matlab Demonstration of EKF
- Lecture 16 - Introduction to Control Systems
- Lecture 17 - Laplace Transforms
- Lecture 18 - Matlab Demonstration of Laplace Transforms
- Lecture 19 - Transfer Function Representation
- Lecture 20 - Matlab Demonstration of Transfer Functions
- Lecture 21 - Transient Response
- Lecture 22 - Matlab Demonstration of Transient Response
- Lecture 23 - Eigenvalues and Eigenvectors
- Lecture 24 - State Space Representations
- Lecture 25 - Matlab Demonstration of State Space Representations
- Lecture 26 - Canonical Forms, State Transition Matrix (STM), Controllability, Observability
- Lecture 27 - Examples on STM, Controllability and Observability
- Lecture 28 - Pole Placement Methods
- Lecture 29 - PID Controller
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- Lecture 31 - Drone Autopilot Design

- Lecture 32 - Drone Autopilot Design
- Lecture 33 - MATLAB Demonstration of Autopilot Design
- Lecture 34 - Global Path Planning
- Lecture 35 - A* Algorithm for Global Path Planning
- Lecture 36 - RRT & RRT* Algorithms Global Path Planning
- Lecture 37 - Introduction to Sense-and-Avoidance (SaA)
- Lecture 38 - Sensor for SAA, Trajectory Prediction, Decision making
- Lecture 39 - Artificial Potential Field (APF)
- Lecture 40 - Control Barrier Function (CBF)
- Lecture 41 - Trajectory tracking with PID Control
- Lecture 42 - Scenario Generation for UAV Operations
- Lecture 43 - Scenario Generation with MATLAB Demonstrations
- Lecture 44 - Autonomous Drone
- Lecture 45 - Essential of Neural Network for Aerial Perception
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- Lecture 48 - Emerging Technology in UAV Swarm
- Lecture 49 - Cooperative Multi-swarm UAV Operation for Forest Fire Fighting
- Lecture 50 - Advanced Drones - Variable Pitch propeler Quadcopter