PD432
Turbo Machinery Dynamics: Design & Operation

Day One

- Rigorous demands of turbo-machines
  - Introduction, Differentiating turbo-machinery types, Weight restrictions of turbine engine for aviation application, Steam and gas turbines for electric power, Planetary gears for helicopter engine, Aero-derivative engine for offshore petroleum platform, Environment and fish-friendly hydraulic turbine, Enhancing power capacity of wind turbine, Example problems, Class quiz
- Turbine engine for transport aircraft
  - High-bypass turbo-fan engine, Propeller driven turbine engine, Aerodynamic challenge of maximizing compression ratio, Achieving enhanced efficiency and performance, Elevated combustion temperature for increased power, Aviation jet engine mission cycle description, Operating life of jet engine components, Withstanding steady and dynamic loads, Example problems, Class quiz
- Power generation with steam and gas turbines
  - Fuel for various applications, Controlling exhaust gas emissions, Efficiency to control production costs, Producing high pressure steam at elevated temperature, Advances in steam turbine technology, Simple cycle gas turbine operation, Heat recovery steam generator, Combined cycle mode, Meeting peak load during high demand, Example problems, Class quiz
- Matching turbine and propeller speeds with planetary gears
  - Unique characteristics of helicopter operation, Stringent requirements in material selection, Helicopter power train, Power for tail rotor, Dual rotor helicopter, Variable pitch propeller blade actuation, Major assemblies of planetary speed reducer, Planet and sun gear bearings, Accessories gear train, Example problems, Class quiz

Day Two

- Power for offshore petroleum platform
  - Lightweight aviation engine technology for aero-derivatives, Electric power away from coastline, Propulsion power for naval and merchant marine ships, Gas compression for pipeline pumping, Turbine operation in marine environment, Accelerated corrosion from sea air and water, Example problems, Class quiz
- Freedom from exhaust gas pollution with hydraulic turbine

- Harnessing power of flowing water, Water powered power plant, Fish-friendly turbine design criteria, Extracting power with fluid machinery, Pure impulse Pelton turbine, Combined impulse - reaction Francis turbine, Reaction type Kaplan turbine, Maximizing turbine performance, Load management, control and governing systems, Example problems, Class quiz

- Green power with wind turbine
  - Exceptionally long propeller blades, Turbine architecture, Principle components, Kinematic evaluation to obtain wind induced loads, Practical solution for less torque, more speed, Anatomy of gearbox for multiple generators, Double-helix bull gears, Producing power with permanent magnets, Generate energy at low wind speed, Example problems, Class

- Vibration theory fundamentals
  - Free vibrations, Forced vibrations with viscous damping, Torsional vibrations in beam, Vibration due to rotating eccentric weight, Cantilever beam subjected to centrifugal force, Vibration in circular disk, Coupled disk-blade system, Example problems, Class quiz

Day Three

- Shaft torsional vibration
  - Simple two inertia system representation, Matrix method of calculation, Critical speeds and modes, Resonant response, Geared and branched systems, Dynamic vibration absorber, Permissible amplitude, Shifting critical speeds, Example problems, Class quiz

- Bearing and seal characteristics
  - Fluid film bearing, Journal bearing types, Dynamic characteristics, Rolling element bearing, Impact of flexible support, Labyrinth and honeycomb seal, Squeeze film damper, Example problems, Class quiz

- Flexural rotor dynamics
  - Dynamics of shaft motion, Support flexibility and critical speeds, Procedure for critical speeds, Critical speed positioning, Synchronous response, Component mode synthesis of large systems, Rotor supported in flexible casing, Stability considerations, Self-excited vibrations, Methods to alleviate vibration instability, Example problems, Class quiz

- Fan and compressor airfoils
  - Finite element method in blade vibrations, Individual blade vibration, Blade flutter, Predicting forced response, Aspects of bladed disk assembly dynamics, Example problems, Class quiz

Day Four

- Propeller blade structural integrity
  - Extracting propulsive power in wind turbine, Twisted and tapered blade, Tip speed ratio in design consideration, Composite blade structure design, Structural load evaluation, Boundary layer separation and stall, Main rotor dominant source of vibrations in helicopter, Embedded actuator to control vibration, Example problems, Class quiz
- Combustor section
  - Fuels for various applications, Combustion principles, Combustor designs and selection, Structural design of combustor liner, Controlling exhaust gas pollutants, Thoroughly mixing air with fuel, Dry low NO_x combustion system, Example problems, Class quiz
- Substrate protection from elevated temperature
  - Thermal distress and fatigue, Coolant delivery to rotating blade, Impingement and surface cooling, Isolating combustor liner from hot gas path, Thermal barrier coating, Combustor acoustic resonance, Example problems, Class quiz
- Turbine blade and vane
  - Primary and secondary flow loss control, Nozzle vane and blade design, Individual blade and bladed disk vibration, Response due to blade-vane interaction, Radial inflow turbine, Turbocharger impeller design, Cyclically symmetric structures, Cumulative damage theory in life prediction, Example problems, Class quiz

Day Five

- Experimental and test measurement
  - Vibration sensors, Measurement techniques, Signal processing, Positioning strain gages on blade, Analyzing transient machinery vibrations, High temperature proximity measurement, Compressor surge investigation using digital velocimetry, Bearing element defect detection, Detection of crack in rotor, Example problems, Class quiz
- Balancing of rotors
  - Assembly and operational procedures, Balance methods, Motion of unbalanced rotors, Balancing of rigid rotor, Single plane balancing of flexible rotor, Overhung thin disk rotor, Multi-plane balancing of flexible rotors, Balance criteria, Example problems, Class quiz
- Turbo-machinery Noise
  - Operating parameters, Jet engine combustion noise, Rotating and stationery blade interaction and noise, Noise generation in industrial turbine, Shaft vibration and noise, Procedures for noise evaluation, Monitoring for quality control, Suppression of jet noise, Damping techniques, Example problems, Class quiz