

PD432 Turbo Machinery Dynamics: Design & Operation

Day One

- Introduction, objectives, and overview
 - Classification and Construction of Turbo-machines – Aircraft engines, steam and gas power generation turbines, marine turbines, centrifugal air and gas compressors, and pumps
- Module 1 - Major Considerations
 - Compressor surge and stall, clearance control, turbulence in gas flow, cycle design parameters, fuel characteristics and combustion, operating requirements, exhaust gas emission and noise restrictions, component life determination, manufacturing methods
- Module 2 - Rotor and Casing Construction
 - Engineering objectives, shafts, rotor disks, spools, curvic couplings, casing and support design, frame configuration, bearing types and geometry, lubrication, squeeze film dampers, seals
- Module 3 - Vibration theory fundamentals
 - Single and multi-degree of freedom, natural frequency and mode shape calculations, harmonic response

Day Two

- Module 4: Shaft torsional vibration
 - Stiffness and inertia characteristics, natural frequencies, mode shapes, forcing functions, forced response, vibration absorbers
- Module 5: Bearings
 - Rolling element and journal bearings, types and geometry, rotor-bearing interaction, bearing dynamic characteristics, squeeze film dampers, seal construction and operation
- Module 6 - Rotor flexural vibrations
 - Flexural Rotor Dynamics – Kinematics and dynamics of rotating systems, analytical procedures, rotor and component modeling, support stiffness, critical speed maps, bearing stiffness effects on rotor motion, exciting forces, vibration response, characteristics of unbalance response
- Module 7 - Rotor dynamic instability
 - Sources, self-excited vibrations, bearing whip, rotor- casing rub, assembly deficiencies, advanced analytical methods

Day Three

- Module 8 - Turbine and compressor blades and vanes
 - Flow path layout, airfoil design, compressor variable stator vanes, dovetail and shroud, blade stress and vibration requirements
- Module 9 - Impellers and bladed disks
 - Radial and axial flow compressors, hub, disk and shroud definition, aerodynamic performance evaluation, centrifugal and dynamic stresses
- Module 10 - Combustors
 - Types, liquid and gas fuels, combustor liner design features, combustion efficiency, fuel injection techniques, swirl inducers, flame stability, cooling of liners, liner support, thermal growth, air-fuel combustion, NOx emissions, combustion oscillations
- Module 11 - Thermal Aspects
 - Turbine blade and vane internal cooling, thermal barrier coating, steady state and transient temperature gradients, thermal stress and fatigue, blade creep growth

Day Four

- Module 12 - Turbo-machinery Diagnostics
 - Measurement of pressure, temperature and vibration, instrumentation, signal analysis, data acquisition and processing, data display procedures, transient data analysis, failure analysis, root cause investigation, fault evaluation.
- Module 13 - Vibration measurement and balancing of rotors
 - Effect and types of unbalance, vibration measurement, single and multi-plane balancing, rigid rotor balance, balancing of flexible rotors, balancing methods, balance specifications
- Module 14 - Turbo-machinery dynamics and noise
 - Combustion and blade passing noise, noise arising from turbulent flow, noise measurement techniques, acoustic treatment, far and near noise regulation
- Module 15 - Design Optimization
 - Optimum design through analysis-evaluation-modification, select design variables, constraints and targets, design trade-offs, achieving target characteristic and associated system response.

Day Five

- Module 16 - Materials
 - Steel, titanium, nickel and chrome super alloys, single crystal and directionally solidified alloys, strength, corrosion and wear resistance, creep, rupture, fracture toughness, fatigue, protective and thermal barrier coatings
- Module 17 - Manufacturing Processes
 - Single crystal and directionally solidified methods, brazing, powder metallurgy, difficulties in machining thin-walled super alloys, dimensional relaxation after machining, coating application process
- Module 18: Computer programs illustrating case histories
 - Computer Programs Illustrating Case Histories – Cycle design, thermodynamic analysis, stress analysis, resonant and off-resonant response, single and multi-plane balancing of rotors, rigid and flexible rotors