Detailed Course Information - Gas Turbine Engines Performance Controls, and Systems Integration

Course Outline

- Principle of thrust generation; propulsive, thermal, core, transmission, and overall efficiencies; SFC to overall efficiency relationship; gross and net thrust.
- Essential thermodynamics: Laws of thermodynamics; enthalpy, internal energy, and entropy; property relationships; variable specific heats; cycle analysis.
- Essential compressible flow: Non-dimensional parameters incl. mass flow function and impulse function; diffuser and nozzle analysis; illustrative examples.
- Non-dimensional/geometric parameters: Advantage of using non-dimensional groups in representing engine/turbomachinery performance; component maps.
- Energy transfer in a generalized turbomachine: Velocity diagram analysis of a generalized (mixed flow) turbomachine, Euler Equation; Illustrative example
- Compressor aero design: Velocity & T-s diagrams; efficiencies; stage characteristics; overall map; degree of reaction; radial equilibrium equation; variable compressor vanes and their use in constant speed machines
- Turbine aero design: Velocity & h-s diagrams; efficiencies; degree of reaction; radial equilibrium eqn; blade twist; overall map; cooling flow accounting
- Combustor characteristics: Multidisciplinary design requirements; performance; stability; pattern factor; flowpaths of aviation and industrial (pre-mixed) designs.
- Component Matching and Integrated System Performance: Satisfying conservation laws; Design point & off-design calculations; compressor/turbine matching
- Multivariable solver: Newton’s 1-D method; multidimensional Newton-Raphson iteration; application to a mixed flow turbofan; model/data matching;
- Turbofan performance enhancement including component improvements, high BPR, mixed exhaust, control optimization, and installation drag reduction.
- Transient engine simulation: Importance of transient response for flight safety and maneuverability; model construction; applications incl. transient component matching, control mode design; start model
- Airplane/Engine Matching: Engine cycle determination from aircraft performance requirements. Iterations of mission requirements, airplane design, and engine cycle
- Hybrid cycles for power generation: Flow path schematics and cycle performance (SFC & Specific Power) incl. combined cycle and aero-derivatives with cycle mods.

Lead Instructor

**Syed J. Khalid** received the MSME degree from Purdue University and the ME (Aerospace) degree from North Carolina State University. He has extensive experience in performance, controls, operability, systems integration, and installation aerodynamics at Pratt & Whitney(Retired), GE Aviation(Retired), Roll-Royce, Lockheed Martin (Retired), and Boeing. He currently works at NASA, KSC. He is inventor/co-inventor of 21 issued patents and 2 pending patents. He has received numerous industry and professional society awards. He has authored 16 technical papers and has made numerous oral presentations. He is an elected member of Phi Kappa Phi.