Flight Control and Hydraulic Systems (AERO0280)

Instructor: Wayne Stout

Course Description
This course covers fundamental design issues, along with analysis and design methodologies for aerospace hydraulic and flight control systems. It includes design requirements, component description and operation, component and system math modeling, component sizing, system layout rationale, system sizing and airframe integration. The course emphasizes the fundamentals and necessary engineering tools (both analytical and otherwise) needed to understand and design aerospace hydraulic and flight control systems. Practical examples and actual systems are presented and discussed throughout the class.

Learning Objectives
• Fundamentals of hydraulic fluid properties and fluid flow
• Operation and characteristics of hydraulic components and systems
• Hydraulic system design issues and system design methodology as well as aircraft integration
• Understand and recognize the fundamental mechanisms used in aircraft flight control
• Evaluation of aircraft flight control systems and design considerations
• Understand failure modes in hydraulic and flight control systems and how they are addressed in system design
• Obtain basic understanding of fly by wire systems

Who Should Attend?
Designed for system- and component-level engineers and managers—including airframe, vendor, industry and government—and educators involved with aerospace mechanical systems.

Course Highlights
• Hydraulic flow fundamentals
• Hydraulic components operation and sizing (actuators, valves, regulators, pumps, motors, accumulators, etc.)
• Servovalve operation and sizing
• Power Control Units (PCUs) function and operation
• Hydraulic system design and airframe integration
• Mechanism fundamentals
• Flight control system design and airframe integration
• Flight control system failure modes and design considerations
• Fly by Wire Systems

Course Outline

Day One
Hydraulic Fluid Properties and Flow
- introduction and background, system design methodology, hydraulic system overview
- fluid properties (density, viscosity, bulk modulus), fluid flow (tubes, orifices, servo),
  spool valves, spool valve control, pressure transients in fluid flow, conservation of mass
  and momentum, basic hydraulic system modeling equations, computer-aided modeling
  of hydraulic systems, examples
Hydraulic Actuators, Motors and Pumps
- operation, fundamental equations, hydraulic natural frequency, sizing, examples

Day Two
Hydraulic Flow Components and Other Components
- operation, fundamental equations for each component and component sizing
- check valves, priority valves, flow control valves, pressure regulators, relief valves,
  shuttle valves, fuses, accumulators, pumps, motors, examples

Day Three
Hydraulic Servovalves, Power Control Units (PCUs)
- Servovalves (flapper, jet pipe and motor controlled)
- Power Control Units (PCUs)
Hydraulic System Design, System Examples
- basic system configurations, power generation systems, landing gear control, brake
  systems, flaps/slats, spoilers, steering, thrust reversers, primary flight control, actuation
  examples (mechanical and electrical)
- hydraulic system design issues, impact of certification regulations, hydraulic system
  design methodology, failure modes, safety analysis issues and redundancy, integration
  with mechanical systems

Day Four
Flight Controls – Mechanism Fundamentals, Electromechanical Actuation, Examples
- mechanical advantage, gearing ratios, building block mechanisms (linkages, bellcranks,
  overcenter, dwell or lost motion, addition/amplification, yokes, cables, override and
  disconnects, etc.), four bar linkages, gearing fundamentals, gearing systems including
  standard/planetary gear trains, power screws, nonlinearities, stiffness, examples of
  mechanical systems
Flight Controls – Gearing Systems, Power Screws, and System Design Requirements
- flight control configurations (reversible, irreversible, fly-by-wire), mechanization of
  flap/slats, flight control system design issues, impact of certification regulations, flight
  control system design methodology and examples
Day Five
Flight Controls – Fly By Wire Overview, Secondary Flight Control Systems
• Flight control system airframe integration, flight control system failure modes (jams, runaways, slow overs), fault detection
• Fly by Wire Systems
• Future directions in flight control

Classroom hours / CEUs
31.50 classroom hours
3.15 CEUs

Certificate Track
Aircraft Design

Course Fees
Early registration course fee: $2,495 if you register and pay by the early registration deadline (45 days out).

Regular registration course fee: $2,695 if you register and pay after the early registration deadline.

U.S. Federal Employee Discount
This course is available to U.S. federal employees at 10% off the registration fee. To receive the federal employee discount, you must enter the code FGVT116 during the checkout process. Please note that you must validate your eligibility to receive this discount by entering your U.S. government email address (ending in .gov or .mil) when creating your online registration profile. This discount is available for both the early registration and regular registration fees.

Netherlands Defence Academy Discount
This course is available to Netherlands Defence Academy employees at a discounted registration fee. Please contact the NDA Procurement and Contracting department for details. Please note that you cannot register using our online system when requesting this discount.

Instructor Bio
Wayne Stout is an independent consultant with a technical specialization in design, analysis, simulation and certification of aircraft mechanical systems. He has more than 30 years of experience in aircraft mechanical systems as an independent consultant and at Bombardier Aerospace, The Boeing Company and Honeywell. Stout has held positions of engineering specialist, systems integrator and chief engineer. His experience covers all design phases from concept to final product across commercial, military and space products. In addition, Stout has been an adjunct professor at Wichita State University and is an FAA DER in flight controls, hydraulics, ECS, pressurization and door mechanisms. Stout received a B.S. in mechanical engineering from the South Dakota School of Mines and Technology, an M.S. in aeronautical
engineering from Wichita State University and a Ph.D. in engineering from Wichita State University. In addition, Stout has published an ibook on Aerospace Hydraulic Systems (available in ibooks and Google Play).

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CONTACT US:

KU Lifelong and Professional Education
Aerospace Short Course Program
12600 Quivira Road, RC 125
Overland Park, Kansas 66213
Email: ProfessionalPrograms@ku.edu
Phone: 913-897-8530 (Registration)