Flight Control and Hydraulic Systems - ONLINE (AERO0285)
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

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

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

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

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

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 Online Registration fee:** $2,195*
- **Regular Online Registration fee:** $2,395

*Early registration fee is available if you register and pay at least 7 days prior to the course start

Registration is open until the first day of the course; however, early registration is encouraged. The online course fee includes individual access to the Zoom course meetings and to course materials, readings, videos, and resources in Blackboard, the University of Kansas Learning Management System.

The 2 textbooks required for this course must be purchased separately. Digital copies are available from both Google Play and iBooks.

**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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