AEROSPACE
SHORT COURSES

Flight Control and Hydraulic Systems (AERO0280)

Instructor: Michael H. Jenkins

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: $2,595 if you register and pay by the early registration deadline (45 days out).

Regular registration course fee: $2,795 if you register and pay after the early registration deadline.

Course Materials

Course materials, including outlines, presentation copies, and supplementary materials, will be accessible through Canvas, KU's online learning system. Instructions to access Canvas will be provided upon completed registration. Students are required to bring a computer or other electronic device with PDF-viewing capabilities with them to class each day. If you require accommodation contact us at professionalprograms@ku.edu and we will work with you on an accessible solution.

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.

Instructor Bio

Mike Jenkins brings over thirty years' experience in the aerospace industry, having worked for several major original equipment manufacturers and as an independent aerospace consultant. He is an FAA DER with authority in 14 CFR Part 25 certification regulations. He specializes in mechanical systems including flight controls, doors, and hydraulics including system definition, requirements, architecture design and layout, and monitoring for traditional mechanical, electro-mechanical, hydro-mechanical, and fly-by-wire systems. He has extensive experience in

sizing and performance analyses, design, schematics, testing, and failure mode and effects for power control units and actuators.

Mr. Jenkins has delegated authority for mechanical systems safety analyses for air conditioning, pressurization, oxygen, and fire protection. He also specializes in structures cabin safety for design and construction, testing and aircraft inspection as well as power plant safety analyses for airplane turbine engines and auxiliary power units. He is an SAE-18 committee member and a co-captain of ARP 4761. Mr. Jenkins holds a Bachelor of Science degree in Mechanical Engineering from the University of Utah. http://michaeljenkinsconsulting.com/

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