AEROSPACE
SHORT COURSES

Airplane Preliminary Design (AERO0130)

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Course Highlights

- Review of drag polar breakdown for subsonic and supersonic airplanes
- Preliminary sizing of airplane take off, empty and fuel weights for a given mission specification
- Performance constraint analyses
- Preliminary configuration selection
- Fundamentals of fuselage and wing layout design
- High-lift and lateral control design considerations
- Fundamentals of powerplant integration
- Fundamentals of landing gear layout design
- Class I weight and balance prediction
- Class II weight, balance and moment of inertia prediction
- Fundamentals of static longitudinal stability
- Deep stall and how to design for recoverability
- Take-off rotation and the effect of landing gear location
- Review of dynamic stability concepts and prediction methods
- Unusual configurations
- Design optimization
- Cost

Course Description

This course provides an overview of the fixed-wing airplane design decision-making process and the relation of design to manufacturing, maintainability and cost-effectiveness. It is applicable to jet transport, turboprop commuter transport, military (trainers, fighter bomber, UAV) and general aviation aircraft. The design process covers sizing (weight, wing area, thrust/power), aerodynamics, weight and balance, stability, control and cost. Numerous examples are shown. Lessons learned and "what to watch out for" are discussed.

Who Should Attend?

Aeronautical engineers, mechanical engineers and electrical engineers needing to learn more about design, pilots with some engineering background, government research laboratory personnel, engineering managers and educators.

Learning Objectives

- How to perform initial design of an airplane
- Sizing of lifting surfaces, engine size, high lift devices
- Weight & balance
- Sizing of control surfaces, trim and flying qualities
- Design to cost
- Lessons learned from accidents and incidents

Course Outline

Day One

- Introduction to airplane design: flowchart of the design process
- Review of drag polar breakdown for subsonic and supersonic airplanes, rapid method for drag polar prediction, check of drag polar realism; review of fundamentals of flight mechanics: take-off and landing characteristics, range, endurance and maneuvering, the payload-range diagram
- Preliminary sizing of airplane take-off weight, empty weight and fuel weight for a given mission specification: applications; sensitivity of take-off weight to changes in payload, empty weight, range, endurance, lift-to-drag ratio and specific fuel consumption; role of sensitivity analyses in directing program-oriented research and development: applications
- Performance constraint analyses: relation between wing loading and thrust-to-weight ratio (or wing loading and weight-to-power ratio) for the following cases: stall speed, take-off field length and landing field length, statistical method for estimating preliminary drag polars, review and effect of airworthiness regulations; relation between wing loading and thrust-to-weight ratio (or wing loading and weight-to-power ratio) for the following cases: climb and climb rate (AEO and OEI), cruise speed and maneuvering; the matching of all performance constraints and preliminary selection of wing area and thrust required: applications

Day Two

- Preliminary configuration selection; what drives unique (advanced) configurations? Discussion of conventional, canard and three-surface configurations; fundamentals of configuration design, step-by-step analysis of the feasibility of configurations: applications
- Fundamentals of fuselage and wing layout design; aerodynamic, structural and manufacturing considerations;
- High-lift and lateral control design considerations; handling quality requirements; icing effects; layout design of horizontal tail, vertical tail and/or canard; static stability and control considerations; the X-plot and the trim diagram; stable and unstable pitch breaks
- Example airplane sizing exercise using the Advanced Aircraft Analysis (AAA)

Day Three

- Fundamentals of powerplant integration: inlet sizing, nozzle configuration, clearance envelopes, installation considerations, accessibility considerations, maintenance

considerations; effect of engine location on weight, stability and control; minimum control speed considerations
- Fundamentals of landing gear layout design; tip-over criteria; FOD considerations; retraction kinematics and retraction volume; take-off rotation
- Class I weight and balance prediction; the c.g. excursion diagram; Class I moment of inertia prediction; importance of establishing control over weight; preliminary structural arrangement for metallic and composite airframes; manufacturing and materials considerations
- V-n diagram
- Class II weight, balance and moment of inertia prediction
- Examples of weight and balance using AAA

Day Four
- Structural design considerations
- Deep stall and how to design for recoverability, effects of the flight control system; control force versus speed and load factor gradients; flying quality considerations; additional stability and control considerations; effect of flaps; minimum control speed with asymmetric thrust
- Take-off rotation and the effect of landing gear location
- Maintenance and accessibility
- Engine installations
- Structural materials
- Fundamentals of static longitudinal stability; the trim diagram, trim considerations for conventional, canard and three-surface designs, tail and canard stall
- Review of dynamic stability concepts and prediction methods; short period, phugoid, spiral roll and Dutch roll modes; flying quality criteria; review of control surface sizing criteria: trim, maneuvering and stability augmentation; flight control system layout and design considerations; mechanical and hydraulically powered flight controls; layout design considerations for redundant "flight-crucial" systems: architectures associated with various types; safety and survivability considerations

Day Five
- Airplane systems: fuel system, control system, de-icing, landing gear, weapons
- Factors to be considered in estimation of: research and development cost and manufacturing and operating cost; the concept of airplane life cycle cost: does it matter in commercial programs? Discussion of 81 rules for "design for low cost"; the break-even point, estimation of airplane "net worth" and its effect on program decision making; other factors in airplane program decision making, finding a market niche, risk reduction through technology validation, design to cost;
- Lessons learned in past programs: do we really learn them?
- Advanced concepts including flying wing, hydrogen-fuel airplanes, twin fuselage, joined wing
- Introduction to design optimization

Classroom hours / CEUs
35.00 classroom hours
3.5 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.

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.

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Your company can realize substantial savings by bringing an aerospace short course to your workplace. On-site delivery is ideal for organizations that need to train 10 or more employees on a specific topic. For more information on on-site course delivery, or to request a cost proposal, please contact us at 913-897-8782, or email us at ProfessionalPrograms@ku.edu.

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