Unit 82: Aircraft Systems Principles and Applications

Unit code: D/601/7188

QCF level: 5

Credit value: 15

Aim

This unit will develop learners' understanding of the principles and components of aircraft power and control systems.

Unit abstract

This unit will enable learners to apply the necessary mechanical, electrical and electronic principles to the examination of aircraft systems. Learners will investigate the principles and components used for the control and performance monitoring of aircraft systems, including transducers and signal conditioning and amplifiers. They will examine the construction and operation of aircraft power systems and the methods used to ensure the integrity and safety of aircraft power distribution. Finally, learners will analyse aircraft control systems and will apply aircraft system control methods to the response of typical aircraft systems.

Learning outcomes

On successful completion of this unit a learner will:

1 Understand the principles and components used for the control and performance monitoring of aircraft systems

2 Understand the operation and performance of aircraft power systems

3 Be able to apply control system fundamentals to the analysis of aircraft control systems.

Unit content

1 **Understand the principles and components used for the control and performance monitoring of aircraft systems**

Aircraft systems: system definition; system state and operating environment; basic electro-mechanical system components eg sensor/transducer, comparator (error detector), signal conditioner and actuation device; G notation; feedback signals; H notation; simple system transfer functions

Transducers: characteristics; operation and applications – optical eg photoconductive cell, photovoltic, photodiode, phototransistor; magnetic eg induction, reluctance, hall-effect; heat eg thermocouple, thermistor, radiation pyrometer; electro-mechanical (limit switches); other eg potentiometers, strain gauges, differential transformers, tacho-generators, pressure sensors, gauges (flow meters), incremental and absolute encoders

Signal conditioning and amplifiers: physical signals; digital and analogue signals; digital to analogue (DAC) and analogue to digital (ADC) converters; signal frequency and amplitude; error signal modification and amplification; open and closed loop control signal paths; introduction to feed-forward signals; mechanical amplifiers and signal conditioners; electrical amplifiers and comparators; active filters

2 **Understand the operation and performance of aircraft power systems**

Power generation: comparison of aircraft pneumatic, hydraulic and electrical power generation eg advantages and disadvantages, circuit operation, power distribution, alternative power supplies

Safety of aircraft power distribution: primary and secondary systems; standby and emergency provision; circuit and system components; duplication and failsafe philosophy

Power actuation systems: principles; constructional detail; control and protection methods; comparison of fluid and electrical power actuation methods and systems eg fluid motors and actuators (single, double acting, rotary, linear, reciprocating piston, spur gear), electric motors and actuators (alternating current (AC) and direct current (DC) motors, induction, synchronous, stepper motor, multi-phase cage motor), linear and rotary actuators

Performance parameters: aircraft applications; high and fractional horsepower; fluid and electrically driven motors and actuators; parameters for DC applications eg speed, torque, on and off load characteristics; parameters for AC applications eg speed of rotation related to applied voltage, power available on constant rated applications

BH023339 – Edexcel BTEC Levels 4 and 5 Higher Nationals specification in Aeronautical Engineering – Issue 1 – June 2010 © Edexcel Limited 2010

3 **Be able to apply control system fundamentals to the analysis of aircraft control systems**

Remote position control systems: applications eg guide vane control of missile, radar aerial movement, positioning of aircraft control surfaces, autopilot platform displacement, gyro compass platform positioning, inertial navigator platform stabilisation, nose wheel steering system, engine speed control, engine pressure ratio signalling and control, engine speed and temperature control, generator frequency and voltage control, hydraulic servo rate and positioning control, electric motor positioning and control, cabin temperature control, engine fuel control

Response of control systems: step and ramp inputs; transient and steady state response; stability of response; overshoot and hunting

Damping methods: damping terms and definitions; Coulomb and viscous friction damping; electrical damping; velocity feedback damping; damping methods used in aircraft systems

System control methods: proportional and derivative control; proportional and integrative control; analogue/digital hybrid control; system response to control methods

Servomechanism control systems: control system definitions; open and closed loop control systems; servo-mechanism motion control; rate and position sensing and control synchros; remote positioning control (RPC) systems

Learning outcomes and assessment criteria

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
LO1 Understand the principles and components used for the control and performance monitoring of aircraft systems	1.1 represent typical aircraft systems in block diagram form 1.2 explain the use of transducers in aircraft systems 1.3 carry out block-diagram reduction exercises and so determine open and closed loop transfer functions, using G and H notation 1.4 explain the operation of signal conditioning and amplifier circuits used in aircraft systems
LO2 Understand the operation and performance of aircraft power systems	2.1 differentiate between mechanical, fluid and electrical methods of power generation for given aircraft usage 2.2 explain the methods used to ensure the continuing integrity and safety of aircraft power distribution 2.3 explain the construction and control and protection methods for aircraft power actuation systems 2.4 evaluate the performance parameters of motors and actuators
LO3 Be able to apply control system fundamentals to the analysis of aircraft control systems	3.1 explain the operation of aircraft remote position control systems 3.2 determine the response of control systems to step, ramp and sinusoidal inputs 3.3 analyse the damping methods used to overcome control system overshoot and hunting 3.4 explain aircraft system control methods and apply them to the response of typical aircraft systems 3.5 select appropriate components and control methods for a given set of typical aircraft control system parameters 3.6 analyse selected aircraft servomechanism control systems.

Guidance

Links

This unit can be linked with *Unit 2: Engineering Science*, *Unit 85: Automatic Flight Control Systems* and *Unit 87: Construction and Operation of Aircraft Fluid Systems*.

Essential resources

Centres need to provide access to a range of electro-mechanical laboratory facilities including equipment needed to analyse servo-systems, transducers, electrical, fluid and mechanical machines/mechanisms and equipment.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of aerospace companies.