**Section 16 Rotary Wing**

**16.1 Principal Aeroderivatives**

**16.2 Forward Flight Static And Dynamic Stability**

**16.1 PRINCIPAL AERODERIVATIVES**

|  |  |  |  |
| --- | --- | --- | --- |
| **Derivative** | **Common Name** | **Principal Contributors** | **Typical Sign** |
| **CONTROL POWER** | | | |
|  | Pitch control power | MR Thrust vector  Mast bending moment  Control gearing  Rotor type  Effective hinge offset | - |
|  | Roll control power | MR Thrust vector  Mast bending moment  Control gearing  Rotor type  Effective hinge offset | - |
|  | Yaw control power | TR thrust  TR moment arm  Control gearing | - |
|  | Heave control power | MR thrust  Control gearing | - |
| **STATIC STABILITY** | | | |
|  | Speed stability | MR flap back  Mast bending moment  Horizontal tailplane | + |
|  | Static/Incidence/Angle of Attack stability | MR flap back  Mast bending moment  Horizontal tailplane  Fuselage |  |
|  | Lateral static stability (dihedral effect) | MR ‘flap back’  TR vertical moment arm  Fuselage | - |
|  | Directional static stability (weathercock effect) | TR thrust  Vertical tailplane  Fuselage | + |
| **DAMPING** | | | |
|  | Drag damping | Rotor drag  Fuselage drag | - |
|  | Side force | Rotor drag  Fuselage drag | - |
|  | Heave damping | MR characteristics | - |
|  | Roll damping | Main rotor  Effective hinge offset | - |
|  | Pitch damping | Main rotor  Effective hinge offset  Horizontal tailplane | - |
|  | Yaw damping | Tail rotor  Vertical tailplane  Fuselage | - |

**16.1 PRINCIPAL AERODERIVATIVES (Continued)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Derivative** | **Common Name** | **Principal Contributors** | **Typical Sign** |

|  |  |  |  |
| --- | --- | --- | --- |
| **CROSS COUPLING** | | | |
|  | Tail rotor roll | Tail rotor vertical position | + |
|  | Pitch change with power | Forward speed  Main rotor | + |
|  | Torque reaction | Torque |  |
|  | Tail rotor drift | Tail rotor |  |

**16.2 FORWARD FLIGHT STATIC AND DYNAMIC STABILITY**

| **Stability Characteristic** | **Principal Influences** | **Typical Test** | **Role Relation** |
| --- | --- | --- | --- |
| Longitudinal Static Stability |  | * Trimmed flight control positions * Trimmed flight control positions - collective | * Control margins * Control inputs progressive, predictable, and in correct sense |
| * Apparent static stability | * Speed selection |
| * Collective fixed static stability | * Speed maintenance |
| Manoeuvre Stability |  | * Apparent manoeuvre stability * Collective fixed manoeuvre stability * Pull-ups/push-overs | * Aggressive turning and manoeuvring flight |
| Longitudinal Dynamic Stability |  | * Excitation of dynamic long term mode * Natural turbulence, release to trim, pulse input | * IMC flight * Transit * Nuisance mode |
| Lateral-Directional Static Stability |  | * Trimmed flight control positions | * Control margins * Control inputs progressive, predictable, and in correct sense |
|  | * Steady heading sideslip (SHSS) | * Sideforce cues * Maintaining balanced flight |
| Lateral Static Stability (Dihedral) |  | * SHSS * Turns on one control – pedal | * Transit * Lateral and out-of-wind transitions * Instrument approaches |
| Directional Static Stability |  | * SHSS * Turns on one control - cyclic | * Transit * Instrument approaches |
| Lateral-Directional Dynamic Stability – Lateral-Directional Oscillations (Dutch Roll Mode |  | * Excitation of LDO via doublet, pulse, or SHSS release to trim | * IMC flight * Transit * Nuisance mode |
| Lateral-Directional Dynamic Stability – Spiral Stability |  | * Turns on one control – cyclic * Time to half/double bank angle | * IMC flight * Turns * Lateral gust response |

**16.3 References:**

Padfield, G.D., (2007), *Helicopter Flight Dynamics*, 2nd Edition, Blackwell Publishing, UK.

Cooke, A., Fitzpatrick, E., (2002), *Helicopter Test and Evaluation*, Wiley Blackwell, UK.

Leishman, J.G., (2006), *Principles of Helicopter Aerodynamics*, 2nd Edition, Cambridge University Press, UK.