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Helicopter Theory

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1. The homogeneous part of the flap equation of a rotor blade in forward flight is given below.

$$\ddot{\beta} + \dot{\beta}\,\gamma\left\{\frac{1}{8} + \frac{\mu}{6}\sin\psi\right\} + \beta\left\{\overline{\omega}_{RF}^{2} + \gamma\mu\cos\psi\left\{\frac{1}{6} + \frac{\mu}{4}\sin\psi\right\}\right\} = 0$$

Assume the following sets of values for Lock Number γ and $\overline{\omega}_{RF}$.

(i) γ=6.0 and $\overline{\omega}_{RF}$=1.0

(ii) γ=12.0 and $\overline{\omega}_{RF}$=1.0

(iii) γ=6.0 and $\overline{\omega}_{RF}$=1.15

(iv) γ=12.0 and $\overline{\omega}_{RF}$=1.15

For each set of values, evaluate the response of the blade at (three) **different** forward speeds from hover up to μ= 0.6. Assume the same initial conditions $\beta(0)$=0.6 and $\dot{\beta}(0)$=0, for all the cases.

(a) Show the time response for **each set separately** in one figure.

(b) Estimate the damping and the frequency of oscillation for each case. Plot your damping and frequency results in a **root-locus plot** for each set of Lock Number and rotating flap natural frequency. **Clearly describe the procedure followed for the estimation of the damping and the frequency**

Note: The derivatives are with respect to non-dimensional time