

# SELECTED TOPICS In Aerospace Engineering

EDITOR

ERWIN SULAEMAN



IIUM Press

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

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EMAIL: [iiumprinting@yahoo.com](mailto:iiumprinting@yahoo.com)

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***SURGE AND ROTATING STALL***

**7.1 Stability of compression systems**

**A** stability analysis can be performed based on the eigenvalues of the linearized, second order Greitzer lumped parameter model. At this point, we introduce the characteristic equation (Greitzer, 1981):

$$s^2 + \left[ \frac{1}{B \frac{d\Psi_t}{d\Phi_t}} - B \frac{d\Psi_c}{d\Phi_c} \right] s + \left[ 1 - \frac{d\Psi_c}{d\Phi_c} \frac{d\Psi_t}{d\Phi_t} \right] = 0 \quad (7.1)$$

where is  $\frac{d\Psi_t}{d\Phi_t}$  the slope of the dimensionless throttle characteristic and  $\frac{d\Psi_c}{d\Phi_c}$  is the slope of the dimensionless compressor characteristic. Thus, the linearized compression system is equivalent to a damped linear oscillator:

$$s^2 + 2\zeta\omega_0 s + \omega_0^2 = 0 \quad (7.2)$$

Application of the Routh-Hurwitz criterion gives that the system is strictly Hurwitz, *i.e.* all the roots have negative real parts, if and only if,

$$\zeta\omega_0 > 0 \quad \text{and} \quad \omega_0^2 > 0 \quad (7.3)$$

Comparison of the previous two equations learns that both stability conditions for the compression system depend on the slopes of the dimensionless compressor and throttle characteristics,

$$\frac{d\Psi_c}{d\Phi_c} < \frac{d\Psi_t}{d\Phi_t} \quad \text{and} \quad \frac{d\Psi_c}{d\Phi_c} < \frac{1}{B^2 \frac{d\Psi_t}{d\Phi_t}} \quad (7.4)$$