AUBURN UNIVERSITY
SAMUEL GINN
COLLEGE OF ENGINEERING
AEROSPACE

AERO 4790/7970 **Advanced Perturbation Methods** **SET VI**
Van der Pol Method of Averaging

1. Use the Method of Averaging to obtain the leading-order approximation for the following initial value problem:

$$\frac{\mathrm{d}^2 y}{\mathrm{d}t^2} + \varepsilon y^2 \frac{\mathrm{d}y}{\mathrm{d}t} + y = 0; \quad y(0) = 1, \quad \dot{y}(0) = 0; \quad \varepsilon \ll 1 \tag{1}$$

2. Use the Method of Averaging to obtain a leading-order approximation for the van der Pol oscillator modeled as:

$$\frac{\mathrm{d}^2 y}{\mathrm{d}t^2} - \varepsilon\left(1 - y^2\right)\frac{\mathrm{d}y}{\mathrm{d}t} + y = 0; \quad y(0) = 0, \quad \dot{y}(0) = 1; \quad \varepsilon \ll 1 \tag{2}$$

3. Use the Method of Averaging to obtain a leading-order approximation for an oscillator with a quintic driving force:

$$\frac{\mathrm{d}^2 y}{\mathrm{d}t^2} + y = \varepsilon y^5; \quad y(0) = 1, \quad \dot{y}(0) = 0; \quad \varepsilon \ll 1 \tag{3}$$

4. Use the Method of Averaging to obtain a leading-order approximation for an oscillator with cubic damping:

$$\frac{\mathrm{d}^2 y}{\mathrm{d}t^2} + \varepsilon\left(\frac{\mathrm{d}y}{\mathrm{d}t}\right)^3 + y = 0; \quad y(0) = 0, \quad \dot{y}(0) = 1; \quad \varepsilon \ll 1 \tag{4}$$