AUBURN UNIVERSITY

SAMUEL GINN
COLLEGE OF ENGINEERING

AEROSPACE

AERO 4970/7970 **Advanced Perturbation Methods** **SET X**

Homotopy

1. Consider a sphere falling freely in air. Letting $u(t)$ denote the instantaneous velocity, one can put

$$\dot{u}(t)+u^2(t)=1; \quad u(0)=0; \quad t \geq 0$$

   a) By choosing $\left\{t^{2m+1} \mid m=0,1,2,3\cdots\right\}$ as base functions, choose a suitable linear operator for this problem.
   b) Solve for u_1 and u_2. How does this solution compare to the Adomian decomposition solution given in class?

2. The cooling of a lumped system subject to convection is described by the following equation:

$$\left(1+\varepsilon u\right)\dot{u}+u=0; \quad u(0)=1$$

   where $u=u(t)$ is the normalized temperature of the system and ε is a parameter.

   a) Choose a proper set of base functions. Hint: Examine the solution of the corresponding problem without the nonlinear terms.
   b) Given the set of base functions, construct a suitable linear operator.
   c) Solve for u_1 and u_2.