Homework #3 **Computational Fluid Dynamics I** Prof. V. Esfahanian
Due Date: 22/7/97 TA: A.Bahrami & M.Fazli

1. Determine the regions where

$$u_{xx} - 2x^2 u_{xz} + u_{yy} + u_{zz} = 0$$

is of hyperbolic, parabolic or elliptic type.

2. Consider following equation

$$\frac{\partial^2 u}{\partial x^2} - t^2 \frac{\partial^2 u}{\partial t^2} = 0$$

with initial conditions as

$$u(x, 0.1) = f(x)$$
$$u_t(x, 0.1) = g(x)$$

for which values of x in $t = 1$, the solution of the equation is affected by $f(x)$ disturbances in $t = 0.1$?

3. Write the Taylor series for the following functions:

a) e^x

b) $\sinh^{-1} x$

c) $\cosh^{-1} x$

4. Determine the order of the following expressions as $h \to 0$:

a) $\ln(1 + h)$

b) $\frac{2}{h} \sinh^{-1}(\frac{h}{2})$

c) $\frac{2}{h} \cosh^{-1}(h)$

5. Compute the first derivative of the function

$$f(x) = \tan(\pi x/4)$$

at $x = 1.5$, using first-order forward and second-order central approximations. Use step sizes of 0.1 and 0.05. Then, use an extrapolation to find better results. Calculate the percentage difference when compared with the exact values. Discuss the results.