**Problem 1.**
Solve the problem

$$u_x + u_y = x \quad u(x,0) = h(x).$$

**Problem 2.**
For the wave equation in $\mathbb{R}^3$

$$u_{tt} = u_{xx} + u_{yy} + u_{zz}$$

find a general form of the plane wave solution. That is solution of the form $u(t,x,y,z) = v(t,s)$ where $s = \alpha x + \beta y + \gamma z$ and $\alpha,\ \beta,\ \gamma \in \mathbb{R}$, $\alpha^2 + \beta^2 + \gamma^2 = 1$.

**Problem 3.**
Let $\Omega = \{x \in \mathbb{R}^3 : \quad |x| > 1\}$. Let $u \in C^2(\bar{\Omega})$ and $u$ satisfies the Laplace equation in $\Omega$, $\Delta u = 0 \quad x \in \Omega$. Show that

$$\max_{\bar{\Omega}} |u| = \max_{\partial\Omega} |u|$$

if $\lim\limits_{x\to\infty} u(x) = 0$.

**Problem 4.**
Show that the problem

$$\begin{aligned} &u_t = -u_{xx} \quad t > 0,\ -\infty < x < \infty \\ &u(x,0) = f(x) \end{aligned}$$

is not well posed. Hint: Consider solutions of the equation

$$u_t = -u_{xx} \quad t > 0,\ -\infty < x < \infty$$

$u_1(x,t) = 1$, and $u_2(x,t) = 1 + \frac{1}{n} e^{n^2 t} \sin(nx)$, $n = 1, 2, 3, \ldots$.