1. Find normal form of the equation

$$u_{xx} + 2u_{xy} + u_{yy} + u_x + u = 0.$$

2. Find normal form of the equation

$$u_{xx} + 2u_{xy} + u_{yy} - u_{zz} = 0.$$

   Write its general solution.

3. Check that the general solution of the equation

$$\partial_x \left(\frac{xy}{x^2+y^2} \partial_x u \right) + \frac{1}{2} \partial_x \left(\frac{x^2-y^2}{x^2+y^2} \partial_y u \right) + \frac{1}{2} \partial_y \left(\frac{x^2-y^2}{x^2+y^2} \partial_x u \right) - \partial_y \left(\frac{xy}{x^2+y^2} \partial_y u \right) = 0$$

   is given by

$$u(x,y) = F(x^2-y^2) + G(xy).$$

4. Solve the wave equation on a half-line $x > 0$:

$$u_{tt} - u_{xx} = \theta_H(1-x), \quad u(0,x) = 0, \quad u_t(0,x) = 0, \quad u(t,0) = 0,$$

   where θ_H is Heaviside theta function:

$$\theta_H(x) = \begin{cases} 0, & x < 0, \\ 1, & x > 0, \\ \frac{1}{2}, & x = 0. \end{cases}$$

   For simplicity, you may consider its solution only for $t > 4$.

5. Solve the wave equation on a half-line $x > 0$:

$$u_{tt} - u_{xx} = 0, \quad u(0,x) = 0, \quad u_t(0,x) = \theta_H(x-3) - \theta_H(x-2), \quad u(t,0) = 0.$$

   For simplicity, you may again consider only the large time case.