1. Let $u(x,t) = x^2 e^{tx} + \sqrt{t}$
   (a) Find $u_x(x,t)$, $u_t(x,t)$, $u_{xx}(x,t)$, $u_{xt}(x,t)$, $u_{tx}(x,t)$, and $u_{tt}(x,t)$.
   (b) Find $u_x(5,3)$, $u_t(x,2t)$, $u_{xx}(x^2,9)$, $u_{xt}(2x,3t)$, $u_{tx}(r+s,0)$, and $u_{tt}(r,r)$.

2. Show directly that the polynomial $p(x,t) = ax^2 + bxt + ct^2 + dx + et + f$ satisfies $p_{xt} = p_{tx}$.

3. Verify that $u(x,t) = -2xt - x^2$ is a solution of the equation $u_t = xu_{xx}$.

4. Consider the equation $3u_x + 2u_t = 0$.
   (a) Find a particular solution of the form $u(x,t) = e^{rx+st}$.
   (b) Discuss the geometric method to find the general solution. What are the characteristic curves? Draw a picture.
   (c) Discuss the coordinate method to find the general solution. Draw a picture.
   (d) Find a solution considering the auxiliary condition $u(0,t) = t^2$.

5. Find the general solution of the following PDEs. Which of them are linear, homogeneous? What are their orders?
   (a) $u_x = t \sin x$;
   (b) $u_{xx} = 1$;
   (c) $u_{xxt} = 1$;
   (d) $u_{xx} = u$.

6. Consider the equation $u_{xx} + u_{tt} = 0$.
   (a) Find a particular solution of the form $u(x,t) = e^{rx+st}$.
   (b) Do Separation of Variables.

7. Separate the variables in
   (a) $x^2 u_{xx} + xu_x - u_t = 0$;
   (b) $u_x - u_y + 2u_z = 0$.

8. Consider $au_x + bu_y + cu_z + du = 0$.
   (a) Find the general solution using the geometric method.
   (b) Find the general solution using the coordinate method.
   (c) Find a solution with $a = 2$, $b = 3$, $c = 1$, and $u(x,0,z) = \sin z$.

9. Consider the PDE $u_x + u_t = u$.
   (a) Apply the geometric method to obtain an idea how the general solution looks like.
   (b) Find the general solution.
   (c) Find the solution u with $u(0,t) = 0$.
   (d) Find the solution u with $u(0,t) = e^t$.
   (e) Find the solution u with $u(0,t) = g(t)$, where g is an arbitrary differentiable function.
   (f) Find the solution u with $u(x,0) = g(x)$, where g is an arbitrary differentiable function.