

### Partial Differential Equations 2024 - Minor 1

1. Consider the PDE  $u_x + u_y = 0$  on  $\mathbb{R}^2$ . Discuss the existence and uniqueness of the solution under the following initial conditions:
  - $u(x, -x) = x$
  - $u(x, x) = x$
  - $u(x, x) = 1$(6 marks)
2. Solve the PDE:  $uu_x + u_y = 1$  with initial conditions  $x = s$ ,  $y = s$  and  $u = s/2$  with  $0 \leq s \leq 1$ .(5 marks)
3. Consider the equation  $p^2 + q^2 = 1$  with initial condition  $u(x, y) = 0$  on the line  $x+y = 1$ . Find the two solutions using the method of characteristics.(5 marks)

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