1. Solve the problem
\[
\frac{\partial^2 u}{\partial x^2} = 3 \frac{\partial u}{\partial t},
\]
\[u(0, t) = u(\pi, t) = 0, \quad t > 0\]
\[u(x, 0) = \sin 2x + 2 \sin 3x - 3 \sin 8x, \quad 0 < x < \pi\]

2. Solve the problem
\[
\frac{\partial^2 u}{\partial x^2} = 9 \frac{\partial^2 u}{\partial t^2},
\]
\[u(0, t) = u(\pi, t) = 0, \quad t > 0\]
\[u(x, 0) = 0, \quad 0 < x < \pi\]
\[\frac{\partial u}{\partial t}(x, 0) = \sin 2x + 2 \sin 3x - 3 \sin 8x, \quad 0 < x < \pi\]

3. Find a formal solution to the problem
\[
\frac{\partial^2 u}{\partial x^2} = 9 \frac{\partial^2 u}{\partial t^2},
\]
\[u(0, t) = u(\pi, t) = 0, \quad t > 0\]
\[u(x, 0) = \sin 4x + 7 \sin 5x\]
\[\frac{\partial u}{\partial t}(x, 0) = \begin{cases} x & 0 < x < \pi/2 \\ \pi - x & \pi/2 < x < \pi \end{cases}\]

4. Find a formal solution to the problem
\[
\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = \frac{\partial u}{\partial t}, \quad 0 < x < \pi, \quad 0 < y < \pi, \quad t > 0
\]
\[u(x, 0, t) = u(x, \pi, t) = 0, \quad 0 < x < \pi, \quad t > 0\]
\[\frac{\partial u}{\partial x}(0, y, t) = \frac{\partial u}{\partial x}(\pi, y, t) = 0, \quad 0 < y < \pi, \quad t > 0\]
\[u(x, y, 0) = x \sin y.\]

5. Solve the Dirichlet problem
\[
\frac{\partial^2 u}{\partial r^2} + \frac{1}{r} \frac{\partial u}{\partial r} + \frac{1}{r^2} \frac{\partial^2 u}{\partial \theta^2} = 0
\]
\[0 \leq r < 2, \quad -\pi \leq \theta \leq \pi\]
\[u(2, \theta) = \cos^2 \theta.\]
6. The equation
\[ \frac{\partial^2 u}{\partial x^2} = a \frac{\partial^2 u}{\partial t^2} + b \frac{\partial u}{\partial t} + cu \]
is known as the equation of telegraphy; here \( a \) and \( b \) are positive constants depending on the physical properties of a telegraph cable. (i) Use the method of separation of variables to find solutions of the form \( u(x, t) = X(x)T(t) \) satisfying \( u(0, t) = u(L, t) = 0 \) for \( t \geq 0 \) and \( a = b = c = 1 \). (ii) Use part (i) to give a formal solution to the problem
\[ \frac{\partial^2 u}{\partial x^2} = \frac{\partial^2 u}{\partial t^2} + \frac{\partial u}{\partial t} + u \]
\( u(0, t) = u(L, t) = 0 \quad t > 0 \)
\( u(x, 0) = f(x) \quad 0 < x < L \)
\( \frac{\partial u}{\partial t}(x, 0) = f(x) \quad 0 < x < L \)
where \( L > 0 \) and \( f(x) \) is a given function on \([0, L]\).