Instructions: Each of the five problems is worth 16 points. Only responses entered in the allocated space for each problem will be graded. Present only the complete solution including all explanation (without scratch work, use the back of the assignment sheet for that purpose) neatly. You must support all of your answers in order to receive credit. Do not remove the staples. Do not turn in the assignment sheet. Grades will be posted on the web this weekend.

1. Solve the IVP $u_t - ku_{xx} + bu = 0$, $u(x,0) = \phi(x)$ (where $b > 0$) by putting $u(x,t) = \mathrm{e}^{-bt}v(x,t)$.
2. Find the general solution of $u_{xx} - u_{xt} - 2u_{tt} = 0$ by "factoring" the equation.
3. Consider a metal rod ($0 < x < l$), insulated along its sides but not at its ends, which is initially at temperature one everywhere. Suddenly both ends are plunged into a bath of temperature zero. Write the differential equation, boundary conditions, and initial conditions. Write the formula for the temperature $u(x,t)$ at later times. In this problem, you can use the infinite series expansion $\sum\limits_{n=1}^{\infty} \frac{1}{2n-1} \sin \frac{(2n-1)\pi x}{l} = \frac{\pi}{4}$.
4. Use the method of separation of variables, discuss the resulting eigenvalue problem, and solve $u_{xx} + u_{tt} = 0$ ($0 < x < l$, $t > 0$), $u(0,t) = u(l,t) = 0$.
5. Find the Fourier series of $f(x) = x$ on $[-\pi, \pi]$ and use it to determine $1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \frac{1}{11} + \ldots$.