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% Parameters and Grid Setup
Lx = 0.02; % Length of the light bulb in meters (x-direction)
Ly = 0.02; % Diameter of the light bulb in meters (y-direction)
Nx = 50; % Number of grid points in the x-direction
Ny = 50; % Number of grid points in the y-direction
dx = Lx / (Nx - 1); % Grid spacing in the x-direction
dy = Ly / (Ny - 1); % Grid spacing in the y-direction
% Thermal Diffusivity
alpha = 1e-4; % Thermal diffusivity in m^2/s
% Simulation Parameters
dt = 0.1; % Time step in seconds
t_final = 600; % Final simulation time in seconds
% Initial and Boundary Conditions
T_initial = 25; % Initial temperature in degrees Celsius
T_hot = 150; % Temperature of the filament (hot spot) in degrees Celsius
T_ambient = 25; % Ambient temperature in degrees Celsius
% Initialize Temperature Matrix
T = ones(Nx, Ny) * T_initial;
% Filament (Hot Spot) Location
filament_x = round(Nx / 2); % X-coordinate of the filament (center)
filament_y = round(Ny / 2); % Y-coordinate of the filament (center)
% Simulation Loop
t = 0;
while t < t_final
% Apply boundary conditions
T(:,1) = T_ambient; % Left boundary (cooling by air)
T(:,end) = T_ambient; % Right boundary (cooling by glass)
% Compute temperature at next time step using forward Euler method
T_new = T;
for i = 2:Nx-1
for j = 2:Ny-1
% 2D Heat Equation
dTdx2 = (T(i+1,j) - 2*T(i,j) + T(i-1,j)) / dx^2;
dTdy2 = (T(i,j+1) - 2*T(i,j) + T(i,j-1)) / dy^2;
% Include heat source (filament)
if i == filament_x && j == filament_y
heat_source = (T_hot - T(i,j)) / (dx^2 + dy^2); % Local heat generation
else
heat_source = 0;
end
% Update temperature using explicit finite difference method
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T_new(i,j) = T(i,j) + alpha * dt * (dTdx2 + dTdy2) + alpha * dt * heat_source;
end
end
% Update temperature matrix
T = T_new;
% Increment time
t = t + dt;
end
% Plotting Temperature Distribution
[X, Y] = meshgrid(linspace(0, Lx, Nx), linspace(0, Ly, Ny));
contourf(X, Y, T', 20, 'EdgeColor', 'none');
colorbar;
xlabel('x (m)');
ylabel('y (m)');
title('Temperature Distribution in Light Bulb');
axis equal;
```