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Methods HW 9 : 11.7, 11.12

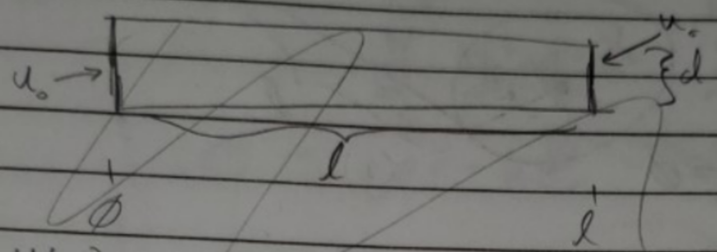
$q = b$

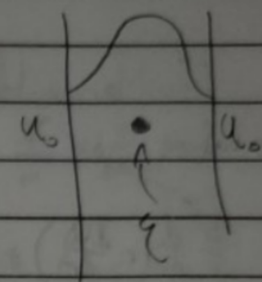
11.7) Internal Floor Heating

thermal conductivity

heat production rate / unit Volume

$$k\frac{d^2u}{dx^2} + q = \emptyset \leftarrow \text{thermal equilibrium}$$





$u(\emptyset) = u_0$ $\qquad$ $u(l) = u_0$

$$\int d^2u = -\int \frac{q}{k}\, dx^2$$

$$\cancel{\int du = \int \frac{q}{k}\, dx + \int C_1 dx \text{ where } C_1 \text{ is an integration constant,}}$$

$$\cancel{u = -\frac{q}{2k}x^2 + C_1 x = x\left(C_1 - \frac{q}{k}x\right)}$$

$$\cancel{u(l) = u_0 = l\left(C_1 - \frac{q}{k}\right)}$$

$$\frac{d}{dx}\left(\frac{du}{dx}\right) = -\frac{b}{k},$$

$$\int \frac{du}{dx}\cdot d = -\frac{b}{k}\int dx,$$

$$\frac{d}{dx}\cdot u = -\frac{b}{k}x + C_1$$

$$u =$$

$$k\frac{d^2u}{dx^2} = -q,$$

$$\int d^2u = -\frac{q}{k}\int dx^2,$$

$$\int du = \int\left(-\frac{q}{k}x + C_1\right)dx,$$

$$u(x) = -\frac{q}{2k}x^2 + C_1 x + C_2,$$

$$u(x) = x\left(-\frac{q}{2k}x + C_1\right) + C_2$$

$$u(\emptyset) = u_0 = C_2,$$

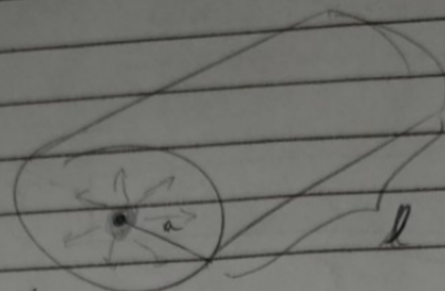
$$u(l) = -\frac{q}{2k}l^2 + lC_1 + \cancel{u_0} = \cancel{u_0}$$

$$C_1 = \frac{q}{2k}l$$

$$\boxed{u(x) = x\frac{q}{2k}\left[l - x\right] + u_0}$$

11.12) Cooling Lizards

$q = 0.5 \frac{W}{kg}$



Equilibrium temp. satisfies

$$\frac{\overset{\text{conductivity}}{k}}{r}\frac{d}{dr}\left(r\frac{du}{dr}\right) + \underset{\text{density}}{\rho} q = \varnothing$$

a) $$\left\{\begin{matrix}\text{rate of} \\ \text{change of} \\ \text{heat in shell}\end{matrix}\right\} = \left\{\begin{matrix}\text{rate heat} \\ \text{conducted} \\ \text{in at } r\end{matrix}\right\} - \left\{\begin{matrix}\text{rate heat} \\ \text{conducted} \\ \text{out at } r+\Delta r\end{matrix}\right\}$$

$\Downarrow$ equilibrium

$$\varnothing = J(r)A(r) - J(r+\Delta r)A(r+\Delta r),$$

$$= -\left[J(r+\Delta r)A(r+\Delta r) - J(r)A(r)\right],$$

$[q] = \frac{W}{kg}$

$$\Downarrow$$

$$= -\frac{d}{dr}\left[J(r)A(r)\right],$$

where $J(r) = -k\frac{du}{dr}$, $A(r) = 2\pi l r$

$$\frac{d}{dr}\left(2\pi l k r \frac{du}{dr}\right) = \varnothing$$

a) Cont.

$$\left\{\begin{matrix}\text{rate of}\\ \text{change of}\\ \text{heat in lizard}\end{matrix}\right\} = \left\{\begin{matrix}\text{rate heat}\\ \text{conducted}\\ \text{into lizard at } r\end{matrix}\right\} - \left\{\begin{matrix}\text{rate heat}\\ \text{conducted}\\ \text{out of lizard at } r\end{matrix}\right\}$$

$$\varnothing \qquad = \frac{\text{heat}}{\text{area}} \quad - $$

$[k] = \frac{W}{mK}$

$$= q \cdot \rho \cdot r \quad - k\frac{dU}{dr}$$

$$\frac{W}{\cancel{kg}} \cdot \frac{\cancel{kg}}{m^3} \cdot m = \frac{W}{m^2} \qquad \frac{W}{m\cancel{K}} \cdot \frac{\cancel{K}}{m} = \frac{W}{m^2}$$

$$\varnothing = q\rho r - k\frac{dU}{dr}$$ → same for time

$$\varnothing = q\rho r - k\frac{d}{dr}\left(r\frac{dU}{dr}\right) \rightarrow \frac{1}{m} \cdot \cancel{m} \cdot \frac{K}{\cancel{m}}$$

→ why is this negative?

$$\frac{k}{r}\frac{d}{dr}\left(r\frac{dU}{dr}\right) - q\rho = \varnothing$$

await asyncio.wait([d... vorumes])

await asyncio.sleep(0.00... time)

$$\frac{d}{dx}\left(\frac{d}{dx}u\right) = -\frac{q}{k},$$

$$\int\frac{d}{dx}u = -\frac{q}{k}\int dx,$$

$$u = -\frac{q}{k}x + c_1$$

$$\int\frac{d}{dx}\cdot du = -\frac{q}{k}\int dx$$

$$du = -\frac{q}{k}x$$

$$\int d\cdot du = \left(-\frac{q}{k}\int dx\right)\cdot dx$$

$$du = \left(-\frac{q}{k}x + c_1\right)dx$$