22.38-05

Exam No. 2 Solution

Problem 1

a) Find H in $f_{xy}(x,y) = H\left[\left(1-\frac{x}{12}\right)-\frac{y}{3}\right]$

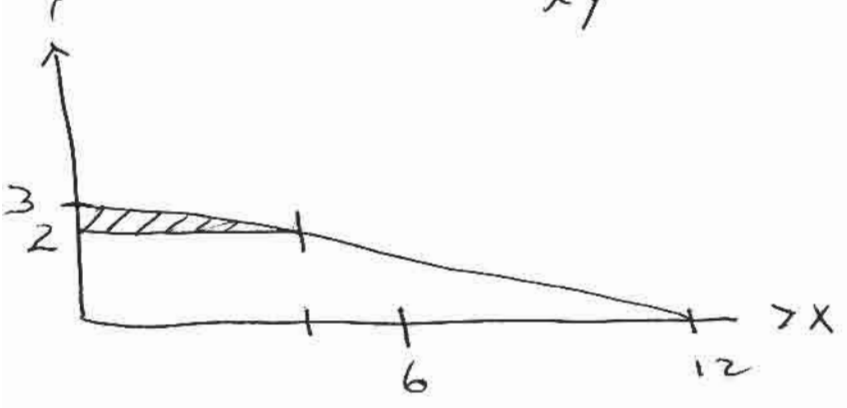
Normalization $1 = \int_0^{12} dx \int_0^{3(1-\frac{x}{12})} dy\, f_{xy}(x,y)$

$\Rightarrow H = \frac{1}{6}$

b) Find $\text{Prob}(y>2 \mid x<6) = \frac{\text{Prob}(y>2, x<6)}{\text{Prob.}(x<6)}$

$$\text{Prob}(y>2, x<6) = \int_0^{4^*} dx \int_2^{3(1-\frac{x}{12})} f_{xy}(x,y) = 0.038$$

* Note that upper limit of integration of x is 4, not 6, because the domain of $y>2$ does not extend beyond $x=4$; or $f_{xy}(x>4, y>2) = 0$.



Releases during transportation over distance, ℓ.

$$E(x|\ell)_{\text{Transport}} = \int_0^{\infty} x\, f_x(x|\ell)\, dx$$

$$= \int_0^{\infty} x\, \gamma\left(\frac{\ell}{\ell_0}\right) e^{-\gamma\left(\frac{\ell}{\ell_0}\right)x}\, dx$$

$$= \frac{1}{\gamma}\left(\frac{\ell}{\ell_0}\right).$$

$$E(x)_{\text{Transport}} = \sum_{i=1}^{2} E(x|\ell_i)_{\text{Transport}}\, \text{Prob}(\ell_i)$$

$$= \frac{1}{\gamma \ell_0}\left[\frac{1}{4}\ell_1 + \frac{3}{4}\ell_2\right] = 8.125\,\text{Ci}$$

Results

Policy	Releases During Storage	Releases During Transportation	Total Releases
1 NPP-Site Storage	10	0	10
2 Central Repository Storage	1	8.25	9.25 *

* = Prefered policy.

$$\text{Prob.}(x<6) = \int_0^6 dx \int_0^{3(1-\frac{x}{12})} f_{x,y}(x,y)\,dy = \frac{7}{8}$$

$$\Rightarrow \text{Prob.}(y>2 \mid x<6) = \frac{0.038}{(\frac{7}{8})} = 0.043,$$

Problem 2

Is it better to store spent fuel rods at the reactor sites or at a central repository? Compare expected radioactive releases via each policy, and select policy resulting in the lower expected release, $E(x)$, magnitude.

$E(X_i) = E(X_i)$ (During Storage for 100 years.) $+ E(X_i)$ (During Transport (at earliest possible date)), for policy, i.

Releases during storage

$$E(x) = \lambda_i t = \begin{cases} 10^{-2} \text{ units for nuclear power plant storage} = 10\,Ci \\ 10^{-3} \text{ " " central repository storage} = 1\,Ci. \end{cases}$$