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Solutions Manual

INTRODUCTION TO HYDROLOGY
FIFTH EDITION

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Prentice Hall
Pearson Education, Inc.
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CHAPTER 1

100*10^6*0.02 = 2*10^6 m^3 1 acre-ft = 43,560 cubic feet cubic meters\*35.31 = cubic feet
\((2*10^6*35.31)/43,560 = 1,612.2\) acre-ft

volume/volume per unit time = time \((500,000*0.3)/(0.5) = 300,000\) sec.
300,000/3,600 = 83.3 hours

\((450 + 500)/2 - (500 + 530)/2 = \text{avg. inflow - avg. outflow}
\)

the change in storage is thus - 40 cfs

\(-40*3600/43560 = -3.31,\) the change in storage in acre-ft.

The initial storage is thus depleted by 3.31 ac-ft 3.31*43,560/35.31 = 4,083 cubic meters

125/365 = 0.34 cm/day = 0.035 cm/day 0.34/2.54 = 0.13 in./day

volume = 5280*5280*0.5 = 13,939,220 cubic feet \(V/Q = \text{time}\)

13,939,220*3600/12 = 1,161,600 sec, or 322.7 hr, or 13.4 days \(ET = P - R\)

\(R = (140*3600*24*365)/(10,000*1000^2) = \)

0.44 m/yr or 44 cm/yr \(ET = 105 - 44 = 61\) cm/yr This is a crude estimate.

equivalent depth = vol/area

inflow = 25*3600*24*365 = 788,400 cubic feet/yr

inflow/(3650*43560) = 4.96 ft/yr

\(E = 100*365/3650 = 10.0\) ft/yr

Hence there is a drop in level of 5.04 ft

\(I_{avg. - O_{avg.}} = \text{change in storage per unit time}\ (20 - 18)*3600 = 7,200\) cubic meters The storage is thus increased by 7,200 cubic meters resulting in a final storage of27,200 cubic meters
CHAPTER 2

Problems in this chapter are to be developed by the instructor.
CHAPTER 3

3.1 - 3.4 To be assigned by instructor.

3.5 For the James River rainfall:

<table>
<thead>
<tr>
<th>Interval in.</th>
<th>f</th>
<th>μ</th>
<th>P(x)</th>
<th>F(x)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(36-37)</td>
<td>2</td>
<td>2</td>
<td>0.057</td>
<td>0.057</td>
</tr>
<tr>
<td>(38-39)</td>
<td>4</td>
<td>6</td>
<td>0.114</td>
<td>0.171</td>
</tr>
<tr>
<td>(40-41)</td>
<td>7</td>
<td>13</td>
<td>0.200</td>
<td>0.371</td>
</tr>
<tr>
<td>(42-43)</td>
<td>9</td>
<td>22</td>
<td>0.257</td>
<td>0.628</td>
</tr>
<tr>
<td>(44-45)</td>
<td>5</td>
<td>27</td>
<td>0.143</td>
<td>0.771</td>
</tr>
<tr>
<td>(46-47)</td>
<td>4</td>
<td>31</td>
<td>0.114</td>
<td>0.885</td>
</tr>
<tr>
<td>(48-49)</td>
<td>2</td>
<td>33</td>
<td>0.057</td>
<td>0.942</td>
</tr>
<tr>
<td>(50-51)</td>
<td>2</td>
<td>35</td>
<td>0.057</td>
<td>0.999</td>
</tr>
</tbody>
</table>

a) \( P(\text{MAR} > 40) = 1.000 - 0.171 = 0.829 = 82.9\% \)

b) \( P(\text{MAR} > 50) = 0.057 = 5.7\% \)

c) \( P(40 < \text{MAR} < 50) = 0.942 - 0.171 = 0.771 = 77.1\% \)

3.6 Using the curve data for a standard normal curve (Table B.1) requires standardization of the limits of the integral,

\[
z = \frac{x - \mu}{\frac{S}{2}} = 2
\]

From Table B.1, the integral is the area to the right of \( F(z = 2) \), or 0.5 - 0.4772 = 0.0228.

3.7 For the data given:

a) The area under the curve must be 1.0 to qualify as a probability density function,

\[
A = \int Pf^\infty dx = b^\infty = 1.0 \cdot 8
\]

This gives \( b = 2.0 \)

b) This is the area between 0.0 and 0.5, or \( 0.5^{3/8} = 0.016 \)

3.8 The histogram is symmetric, has zero skew, and mean = median = mode.
Sketch for Prob. 3.8 Since area to right of mode is 50%, \( F(\text{mode}) = 50\% \) and \( T = 2 \text{ yr.} \)

Given \( x = 10.3, s = 1.1, C_v = 0.11, n = 20 \):

\[
\text{S.E.}(x) = s\sqrt{\frac{1}{n}}T^\gamma = 1.1 \sqrt{\frac{1}{20}} = 0.245
\]

\[
\text{S.E.}(s) = \frac{s}{V2n} = \frac{1.1}{\sqrt{40}} = 0.0174
\]

\[
\text{S.E.}(C_v) = \frac{C_v}{V1 + 2C_v^2\sqrt{\frac{n}{2}}} = \frac{0.11}{V1 + 2(0.11)^2/20} = 0.017
\]

\[
95\% \text{ C.I.: } z = \pm 1.96 \text{ x} \pm 1.96 (\text{S.E.}_x) = 10.3 \pm 0.48 = \{10.78 \text{ to } 9.82\}
\]

Because the median divides the area in half, most of the area would be to the right of the median. The distribution is probably skewed right.

Sketch:

\[f(x)\]

**Sketch for p.d.f. for Prob. 3.11**
a) Left skewed

b) Negative because Pearson skew = \( \frac{\text{mean} - \text{mode}}{\text{sx}} \)

3.12 For the 30,000 cfs value:

\[ T_r = 60 \text{ yrs} = 20 \text{ yrs} \]
\[ \frac{3}{3} \times 3.12 \]

3.13 Frequency analysis:

a)  

<table>
<thead>
<tr>
<th>m rank</th>
<th>Peak value</th>
<th>( \frac{m}{T_r} )</th>
<th>T_r = 1/F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1000</td>
<td>.1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>900</td>
<td>.2</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>800</td>
<td>.3</td>
<td>3.33</td>
</tr>
<tr>
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<td>.4</td>
<td>2.5</td>
</tr>
<tr>
<td>5</td>
<td>600</td>
<td>.5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>500</td>
<td>.6</td>
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<td></td>
</tr>
<tr>
<td>9</td>
<td>200</td>
<td>.9</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>100</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

By interpolation, 4-yr value is

\[ 800 + \frac{4 - 3.33}{5 - 3.33} \times (100) \]

\[ = 840 \text{ cfs} \]

b) Using Table B.1,

\[ Q_{4-\text{yr}} = Q + K s_Q = 550 + .67(300) = 750 \text{ cfs} \]

3.14 For an annual precipitation of 30 in.

a) \[ P(x > 30) = G(30) \]

\[ z = \frac{(30 - 27.6)}{6.06} = 0.396 \]

\[ F(z) = 0.15392 \]
3.15 \( P(E, U E_2) = P(Ei) + P(E_2) - P(E \cap E_2) \)

a) If \( E_j \) and \( E_2 \) are independent, \( P(Ei|E_2) = P(Ei) \)
    and \( P(EioE_2) = P(Ej) \times P(E_2) \)
    \( P(E, U E_2) = 0.3 + 0.3 - 0.3 \times 0.3 = 0.51 \)

b) If dependent, with \( P(Ei | E_2) = 0.1 \),
    \( P(Ei \geq E_2) = 0.1 \times 0.3 = 0.03 \)
    and \( P(E, U E_2) = 0.3 + 0.3 - 0.03 = 0.57 \)

3.16 \( P(A) = 0.4, P(\text{no } A) = P(A) = 1 - 0.4 = 0.6 \)
\( P(B) = 0.5, P(\text{no } B) = P(B) = 1 - 0.5 = 0.5; \)

A and B independent

a) \( P(A \cap B) = P(A) \times P(B) = 0.4 \times 0.5 = 0.20 \)

b) \( P(A \cap B) = P(A) \times P(B) = 0.6 \times 0.5 = 0.30 \)

\( P(E_1|E_2) = 0.9, P(Ei|E_1) = 0.2, P(E, n E_2) = 0.1 \)
\( P(Ei) = P(E, n E_2)/P(E_2|E_1) = 0.1/0.2 = 0.5 \ P(E_2) \)
\( = P(Ei n E_2)/P(Ei|E_2) = 0.1/0.9 = 0.111 \)

3.17 Two random events that are:

3.18 a) Mutually exclusive:
    A: Precipitation today exceeds 4 in.
    B: Precipitation today does not exceed 3"

b) Dependent:
    A: Precipitation today exceeds 4 in.
    B: Runoff today exceeds 1 in.

c) Mutually exclusive and dependent:
    A: Precipitation today does not exceed 4 in.
    B: Runoff today exceeds 6 in.

d) Neither mutually exclusive nor dependent:
    A: Today's precipitation exceeds 4 in.