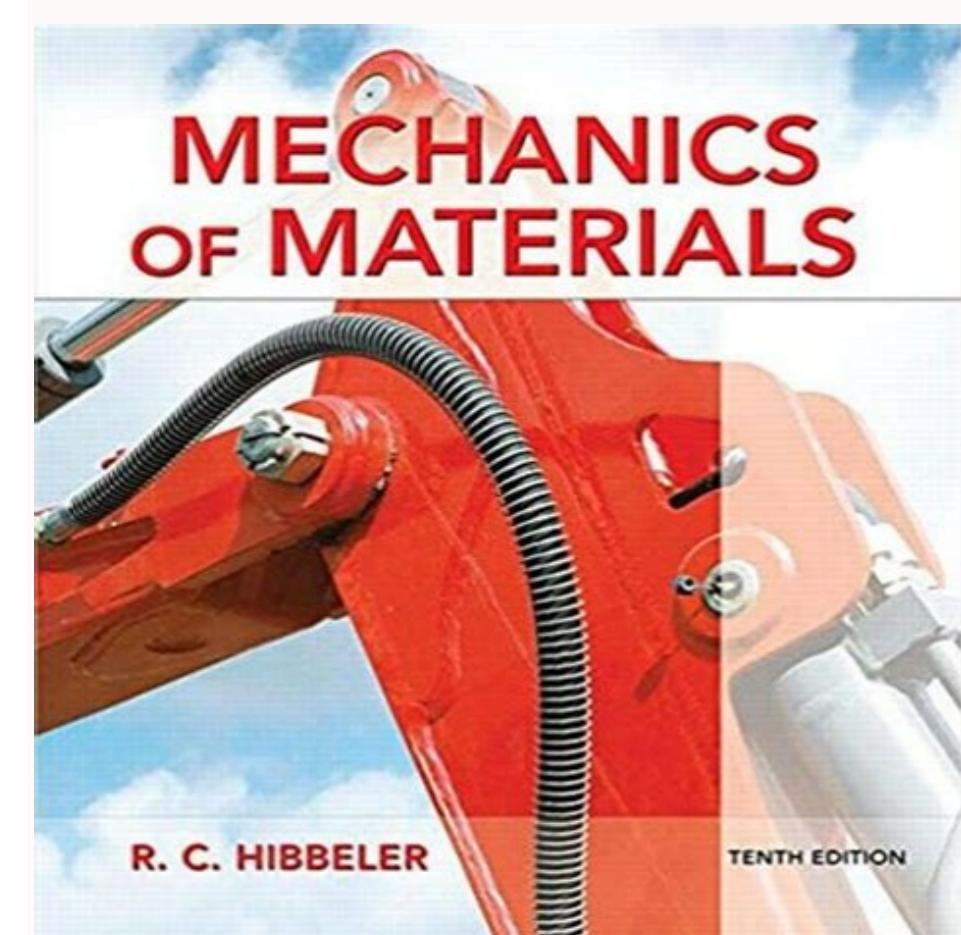
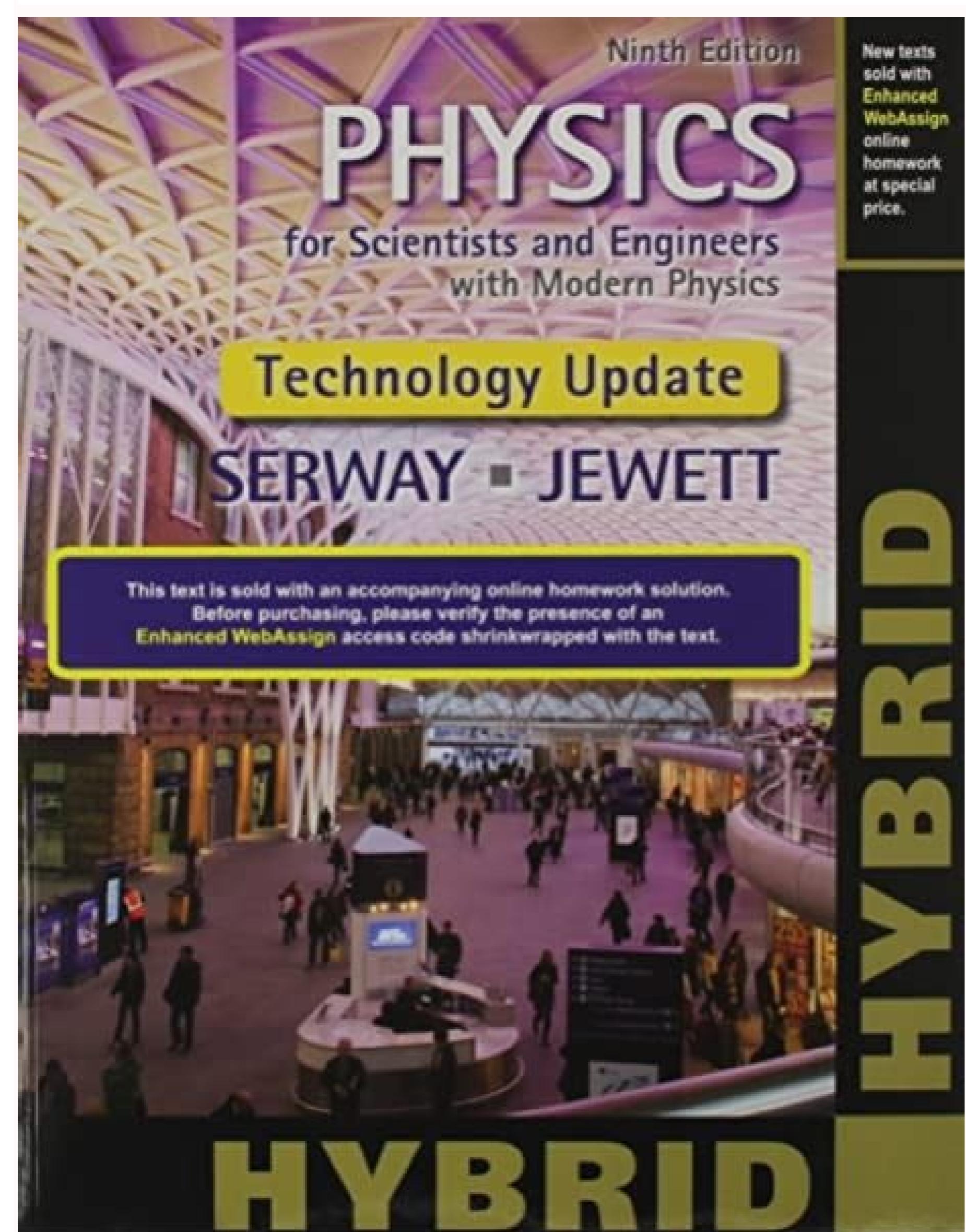
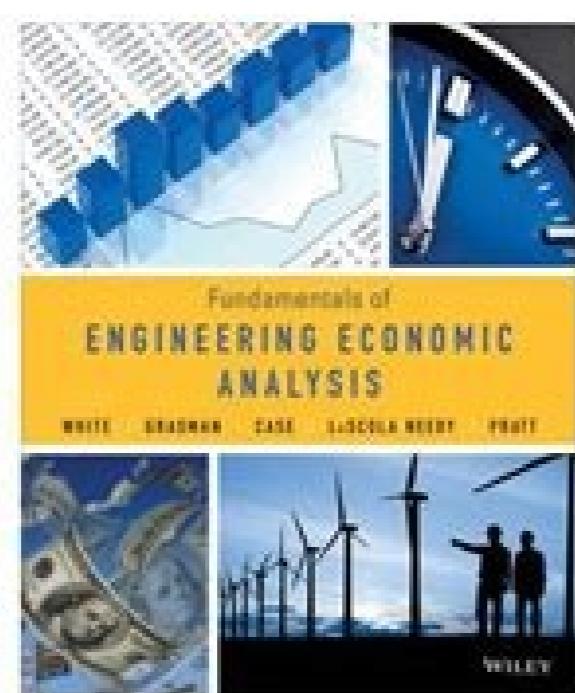
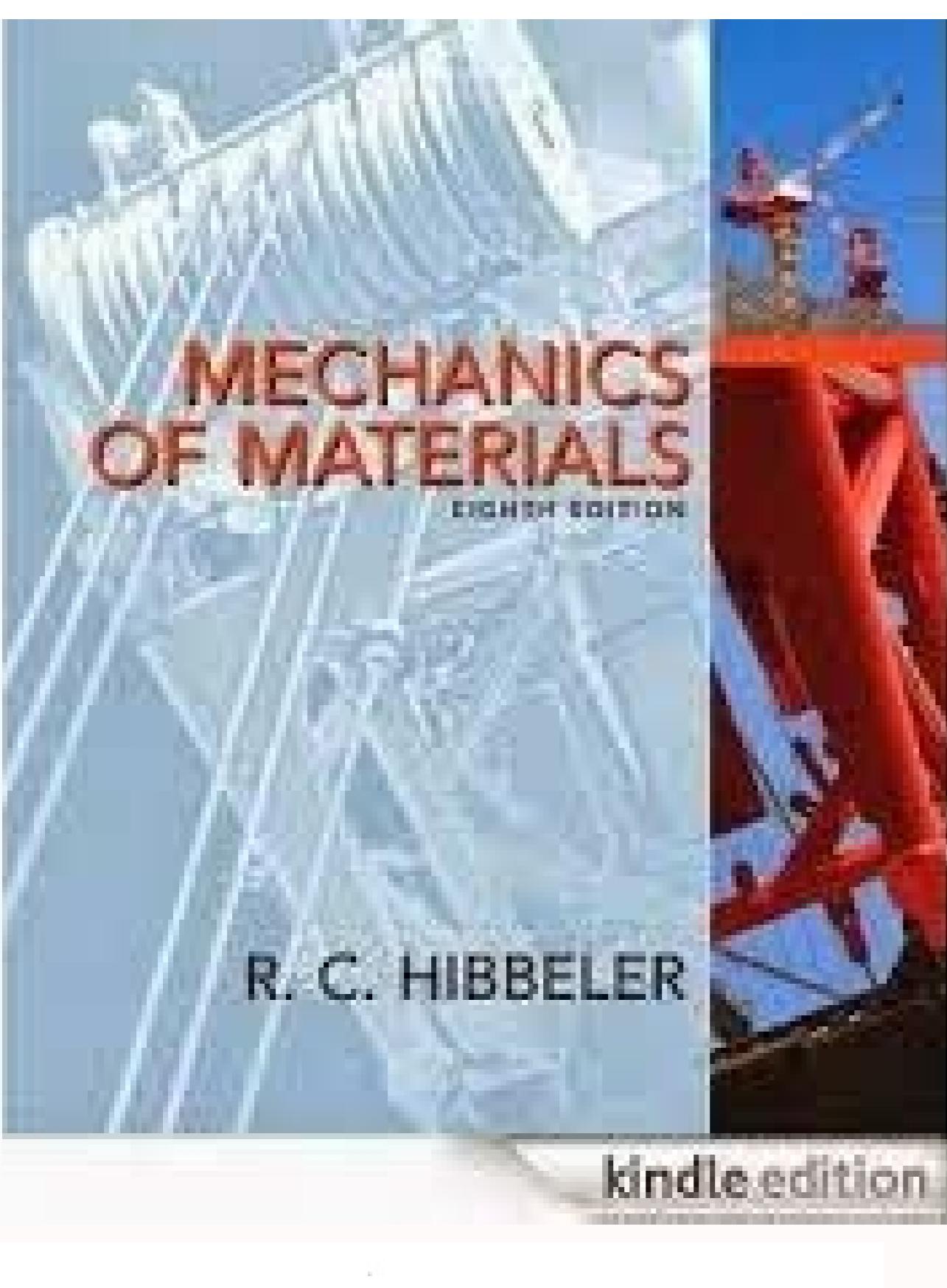


I'm not a robot!





R. C. HIBBELER

Kindle edition

SOLUTION

The location of the neutral surface from the center of curvature of the hook, Fig. a, can be determined from

$$R = \frac{A}{\sum \int_A^B \frac{dx}{r}}$$



where $A = \pi(0.25)^2 = 0.19625 \text{ in}^2$

$$\sum \int_A^B \frac{dx}{r} = 2\pi(\sqrt{r^2 - c^2}) = 2\pi(1.75 - \sqrt{1.75^2 - 0.25^2}) = 0.12278 \text{ in.}$$

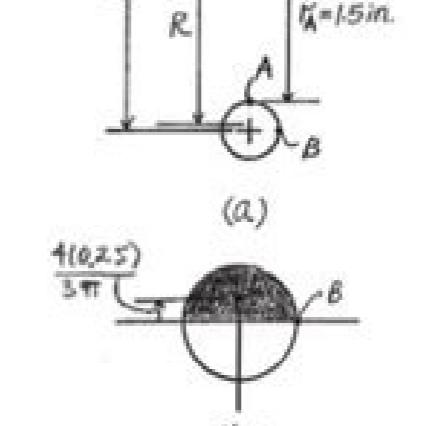
Thus, $R = \frac{0.0625\pi}{0.12278} = 1.74103 \text{ in}$

Then, $r = \bar{r} - R = 1.75 - 1.74103 = 0.089746 \text{ in}$

Referring to Fig. b, l and Q_B are computed as

$$I = \frac{1}{4}(0.25)^4 = 0.976565(\text{in}^4)^{-1} \text{ in}^4$$

$$Q_B = \bar{r}^2 A = \frac{4(0.25)}{3\pi} \left[\frac{1}{2}(0.25)^2 \right] = 0.010467 \text{ in}^3$$



Consider the equilibrium of the FBD of the hook's cut segment, Fig. c.

$$\Sigma \cdot \Sigma F_x = 0; \quad N - 80 \cos 45^\circ = 0 \quad N = 56.57 \text{ lb}$$

$$\Sigma \cdot \Sigma F_y = 0; \quad 80 \sin 45^\circ = V = 0 \quad V = 56.57 \text{ lb}$$

$$\Sigma \cdot \Sigma M = 0; \quad M - 80 \cos 45^\circ (1.74103) = 0 \quad M = 98.49 \text{ lb-in}$$

The normal stress developed is the combination of a tensile and bending stress. Thus,

$$\sigma = \frac{N}{A} + \frac{M(R - r)}{I} \quad \text{Ans.}$$

Here, $M = 98.49 \text{ lb-in}$ since it tends to reduce the curvature of the hook. For point B, $r = 1.75 \text{ in}$.

$$\sigma = \frac{56.57}{0.0625\pi} + \frac{(98.49)(1.74103 - 1.75)}{0.976565(\text{in}^4)^{-1}} = 1.48 \text{ psi (T)}$$

The shear stress is contributed by the transverse shear stress only. Thus,

$$\tau = \frac{VQ_B}{Bt} = \frac{56.57}{3\pi(0.010467)} = 364 \text{ psi} \quad \text{Ans.}$$

The state of stress at point B can be represented by the element shown in Fig. d.

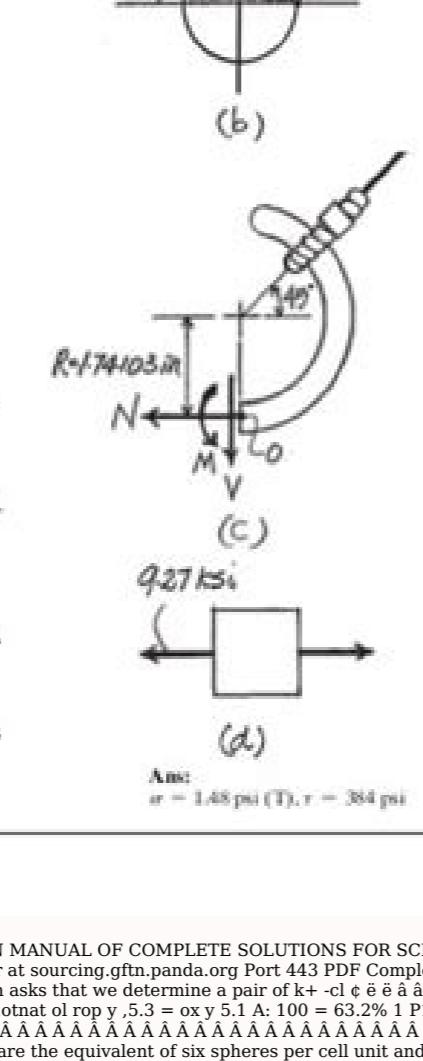


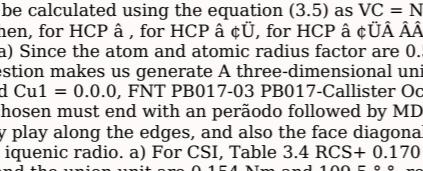
Fig. c

Figure 10-73.

The hook is subjected to the force of 80 lb. Determine the state of stress at point B at section a-a. The cross section has a diameter of 0.5 in. Use the curved-beam formula to calculate the bending stress.

The location of the neutral surface from the center of curvature of the hook, Fig. a, can be determined from

$$R = \frac{A}{\sum \int_A^B \frac{dx}{r}}$$



where $A = \pi(0.25)^2 = 0.19625 \text{ in}^2$

$$\sum \int_A^B \frac{dx}{r} = 2\pi(\sqrt{r^2 - c^2}) = 2\pi(1.75 - \sqrt{1.75^2 - 0.25^2}) = 0.12278 \text{ in.}$$

Thus, $R = \frac{0.0625\pi}{0.12278} = 1.74103 \text{ in}$

Then, $r = \bar{r} - R = 1.75 - 1.74103 = 0.089746 \text{ in}$

Referring to Fig. b, l and Q_B are computed as

$$I = \frac{1}{4}(0.25)^4 = 0.976565(\text{in}^4)^{-1} \text{ in}^4$$

$$Q_B = \bar{r}^2 A = \frac{4(0.25)}{3\pi} \left[\frac{1}{2}(0.25)^2 \right] = 0.010467 \text{ in}^3$$

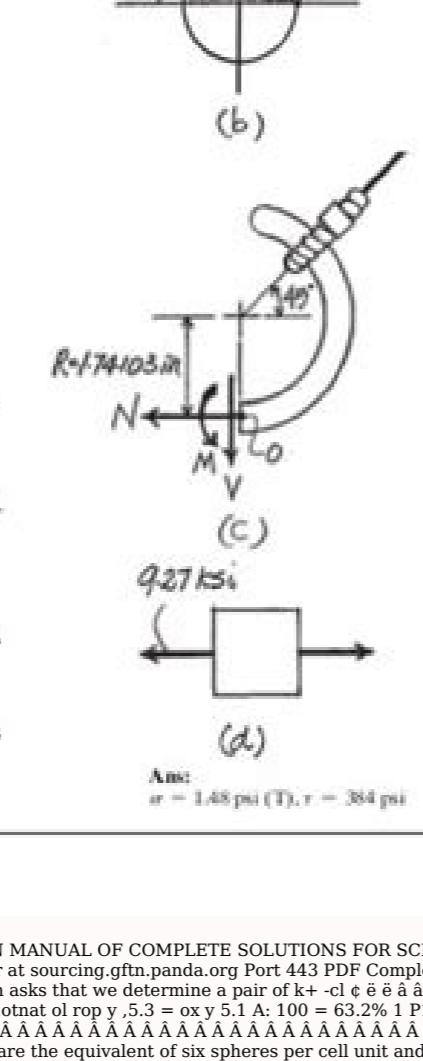


Fig. c

Consider the equilibrium of the FBD of the hook's cut segment, Fig. c.

$$\Sigma \cdot \Sigma F_x = 0; \quad N - 80 \cos 45^\circ = 0 \quad N = 56.57 \text{ lb}$$

$$\Sigma \cdot \Sigma F_y = 0; \quad 80 \sin 45^\circ = V = 0 \quad V = 56.57 \text{ lb}$$

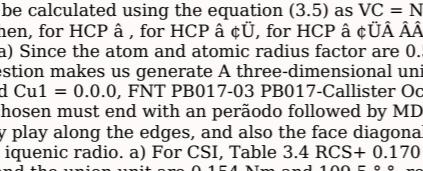
$$\Sigma \cdot \Sigma M = 0; \quad M - 80 \cos 45^\circ (1.74103) = 0 \quad M = 98.49 \text{ lb-in}$$

The normal stress developed is the combination of a tensile and bending stress. Thus,

$$\sigma = \frac{N}{A} + \frac{M(R - r)}{I} \quad \text{Ans.}$$

Here, $M = 98.49 \text{ lb-in}$ since it tends to reduce the curvature of the hook. For point B, $r = 1.75 \text{ in}$.

$$\sigma = \frac{56.57}{0.0625\pi} + \frac{(98.49)(1.74103 - 1.75)}{0.976565(\text{in}^4)^{-1}} = 1.48 \text{ psi (T)}$$



where $A = \pi(0.25)^2 = 0.19625 \text{ in}^2$

$$\sum \int_A^B \frac{dx}{r} = 2\pi(\sqrt{r^2 - c^2}) = 2\pi(1.75 - \sqrt{1.75^2 - 0.25^2}) = 0.12278 \text{ in.}$$

Thus, $R = \frac{0.0625\pi}{0.12278} = 1.74103 \text{ in}$

Then, $r = \bar{r} - R = 1.75 - 1.74103 = 0.089746 \text{ in}$

Referring to Fig. b, l and Q_B are computed as

$$I = \frac{1}{4}(0.25)^4 = 0.976565(\text{in}^4)^{-1} \text{ in}^4$$

$$Q_B = \bar{r}^2 A = \frac{4(0.25)}{3\pi} \left[\frac{1}{2}(0.25)^2 \right] = 0.010467 \text{ in}^3$$

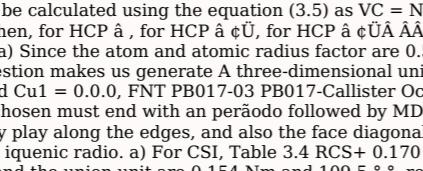


Fig. c

Consider the equilibrium of the FBD of the hook's cut segment, Fig. c.

$$\Sigma \cdot \Sigma F_x = 0; \quad N - 80 \cos 45^\circ = 0 \quad N = 56.57 \text{ lb}$$

$$\Sigma \cdot \Sigma F_y = 0; \quad 80 \sin 45^\circ = V = 0 \quad V = 56.57 \text{ lb}$$

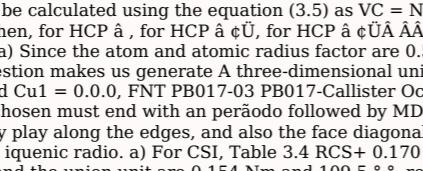
$$\Sigma \cdot \Sigma M = 0; \quad M - 80 \cos 45^\circ (1.74103) = 0 \quad M = 98.49 \text{ lb-in}$$

The normal stress developed is the combination of a tensile and bending stress. Thus,

$$\sigma = \frac{N}{A} + \frac{M(R - r)}{I} \quad \text{Ans.}$$

Here, $M = 98.49 \text{ lb-in}$ since it tends to reduce the curvature of the hook. For point B, $r = 1.75 \text{ in}$.

$$\sigma = \frac{56.57}{0.0625\pi} + \frac{(98.49)(1.74103 - 1.75)}{0.976565(\text{in}^4)^{-1}} = 1.48 \text{ psi (T)}$$



where $A = \pi(0.25)^2 = 0.19625 \text{ in}^2$

$$\sum \int_A^B \frac{dx}{r} = 2\pi(\sqrt{r^2 - c^2}) = 2\pi(1.75 - \sqrt{1.75^2 - 0.25^2}) = 0.12278 \text{ in.}$$

Thus, $R = \frac{0.0625\pi}{0.12278} = 1.74103 \text{ in}$

Then, $r = \bar{r} - R = 1.75 - 1.74103 = 0.089746 \text{ in}$

Referring to Fig. b, l and Q_B are computed as

$$I = \frac{1}{4}(0.25)^4 = 0.976565(\text{in}^4)^{-1} \text{ in}^4$$

$$Q_B = \bar{r}^2 A = \frac{4(0.25)}{3\pi} \left[\frac{1}{2}(0.25)^2 \right] = 0.010467 \text{ in}^3$$

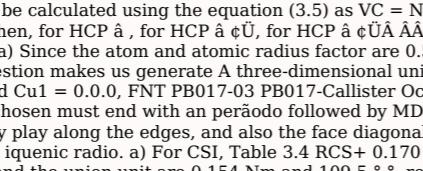


Fig. c

Consider the equilibrium of the FBD of the hook's cut segment, Fig. c.

$$\Sigma \cdot \Sigma F_x = 0; \quad N - 80 \cos 45^\circ = 0 \quad N = 56.57 \text{ lb}$$

$$\Sigma \cdot \Sigma F_y = 0; \quad 80 \sin 45^\circ = V = 0 \quad V = 56.57 \text{ lb}$$

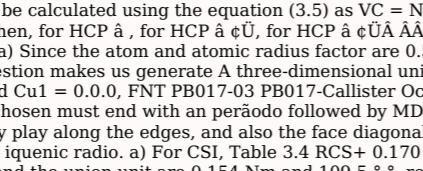
$$\Sigma \cdot \Sigma M = 0; \quad M - 80 \cos 45^\circ (1.74103) = 0 \quad M = 98.49 \text{ lb-in}$$

The normal stress developed is the combination of a tensile and bending stress. Thus,

$$\sigma = \frac{N}{A} + \frac{M(R - r)}{I} \quad \text{Ans.}$$

Here, $M = 98.49 \text{ lb-in}$ since it tends to reduce the curvature of the hook. For point B, $r = 1.75 \text{ in}$.

$$\sigma = \frac{56.57}{0.0625\pi} + \frac{(98.49)(1.74103 - 1.75)}{0.976565(\text{in}^4)^{-1}} = 1.48 \text{ psi (T)}$$



where $A = \pi(0.25)^2 = 0.19625 \text{ in}^2$

$$\sum \int_A^B \frac{dx}{r} = 2\pi(\sqrt{r^2 - c^2}) = 2\pi(1.75 - \sqrt{1.75^2 - 0.25^2}) = 0.12278 \text{ in.}$$

Thus, $R = \frac{0.0625\pi}{0.12278} = 1.74103 \text{ in}$

Then, $r = \bar{r} - R = 1.75 - 1.74103 = 0.089746 \text{ in}$

Referring to Fig. b, l and Q_B are computed as

$$I = \frac{1}{4}(0.25)^4 = 0.976565(\text{in}^4)^{-1} \text{ in}^4$$

$$Q_B = \bar{r}^2 A = \frac{4(0.25)}{3\pi} \left[\frac{1}{2}(0.25)^2 \right] = 0.010467 \text{ in}^3$$

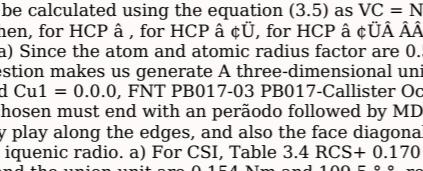


Fig. c

Consider the equilibrium of the FBD of the hook's cut segment, Fig. c.

$$\Sigma \cdot \Sigma F_x = 0; \quad N - 80 \cos 45^\circ = 0 \quad N = 56.57 \text{ lb}$$

$$\Sigma \cdot \Sigma F_y = 0; \quad 80 \sin 45^\circ = V = 0 \quad V = 56.57 \text{ lb}$$

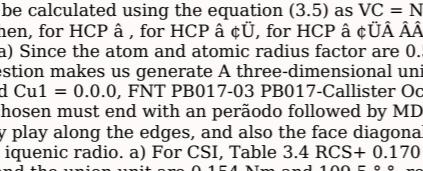
$$\Sigma \cdot \Sigma M = 0; \quad M - 80 \cos 45^\circ (1.74103) = 0 \quad M = 98.49 \text{ lb-in}$$

The normal stress developed is the combination of a tensile and bending stress. Thus,

$$\sigma = \frac{N}{A} + \frac{M(R - r)}{I} \quad \text{Ans.}$$

Here, $M = 98.49 \text{ lb-in}$ since it tends to reduce the curvature of the hook. For point B, $r = 1.75 \text{ in}$.

$$\sigma = \frac{56.57}{0.0625\pi} + \frac{(98.49)(1.74103 - 1.75)}{0.976565(\text{in}^4)^{-1}} = 1.48 \text{ psi (T)}$$



where $A = \pi(0.25)^2 = 0.19625 \text{ in}^2$

$$\sum \int_A^B \frac{dx}{r} = 2\pi(\sqrt{r^2 - c^2}) = 2\pi(1.75 - \sqrt{1.75^2 - 0.25^2}) = 0.12278 \text{ in.}$$

Thus, $R = \frac{0.0625\pi}{0.12278} = 1.74103 \text{ in}$

Then, $r = \bar{r} - R = 1.75 - 1.74103 = 0.089746 \text{ in}$

Referring to Fig. b, l and Q_B are computed as

$$I = \frac{1}{4}(0.25)^4 = 0.976565(\text{in}^4)^{-1} \text{ in}^4$$

$$Q_B = \bar{r}^2 A = \frac{4(0.25)}{3\pi} \left[\frac{1}{2$$

