

# **Essential Equations for the FE Exam Using the HP 33s**

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**Equation 6: Beam Deflection** (Handbook p. 43)

$$\delta = \frac{Px^2}{6EI}(-x + 3a) \quad (\text{for } x \leq a)$$

$\delta$  is positive downward.

































**Entered as**

$$D=P \times SQ(X) \times (-X+3 \times A) \div 6 \div E \div I$$

**Sessions** AM, PM

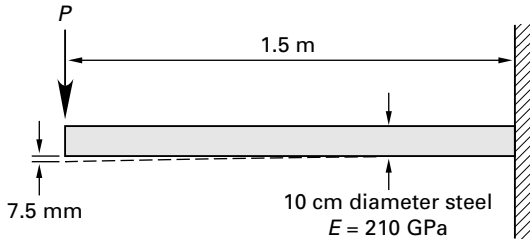
**Disciplines** General, Mechanical

**Variables** The hp 33s can only recognize single Roman letters as variables. The Greek letter  $\delta$  (delta) is replaced with  $D$ , for deflection. If preferred, different letters can be assigned to the variables, but will lead to a different checksum at the end.

| Keys  | Display                | Description   |
|---|------------------------|---|
|     | D= ■                   | Selects Equation mode and starts new equation. $D$ represents deflection ( $\delta$ ).                                  |
|          |                        |   |
|    |                        |   |
|     | D=P ■                  | $P$ represents load.  |
|          | D=P × SQ(X) ■          | Enters $X^2$ .  |
|          |                        |   |
|       | D=P × SQ(X) × (- ■     | Changes sign of next number.  |
|    |                        |   |
|    | =P × SQ(X) × (-X+ ■    | Equation is now longer than the hp 33s display. For instructions on scrolling left and right, see How to Use This Book. |
|    | × SQ(X) × (-X+ 3 _     | Cursor changes for entering digits.   |
|    | SQ(X) × (-X+3 × A ■    | Enters variable $A$ .   |
|    | (X) × (-X+3 × A) ÷ ■   |   |
|    | ) × (-X+3 × A) ÷ 6 _   | Cursor changes for entering digits.   |
|    | × (-X+3 × A) ÷ 6 ÷ E ■ | $E$ represents modulus of elasticity.   |

**PROBLEM 6**

For the fixed steel rod shown, what is most nearly the force,  $P$ , necessary to deflect the rod a vertical distance of 7.5 mm?



- (A) 6900 N
- (B) 8800 N
- (C) 11 000 N
- (D) 17 000 N

**SOLUTION 6**

Use the formula for beam deflection (Equation 6, p. 15) and solve for  $P$ . The formula for moment of inertia,  $I$ , is  $\pi r^4/4$ . This can be calculated during the solving process, as shown below. It could also be calculated separately before solving.

| Keys | Display                        | Description   |
|------|--------------------------------|---|
| EQN  | $D=P \times SQ(X) \times (-X+$ | Enters Equation mode. Scroll through list to bring needed equation to bottom line of display. |
|      | $D?$<br>0.0000                 | Starts to solve for $P$ . Prompts for $D$ and displays current value.                         |
|      | $X?$                           | Enters 0.0075 for $D$ . Prompts for $X$   |
|      | 0.0000                         | and displays current value.   |
|      |                                |   |
|      | $A?$                           | Enters 1.5 for $X$ . Prompts for $A$ and  |
|      | 0.0000                         | displays current value.   |
|      | $E?$                           | Enters 1.5 for $A$ . Prompts for $E$ and  |
|      | 0.0000                         | displays current value.   |

|  |              |  |
|--|--------------|--|
| <b>2</b> <b>1</b> <b>0</b> <b>E</b>    | I?           | Enters $210 \times 10^9$ for $E$ . Prompts for |
| <b>9</b> <b>R/S</b>                    | 0.0000       | $I$ and displays current value.                |
| <b>0</b> <b>.</b> <b>0</b>             | I?           | Enters $(0.05)^4 \times \pi \div 4$ .          |
| <b>5</b> <b>ENTER</b>                  | 4.9087E-6    |  |
| <b>4</b> <b>y<sup>x</sup></b> <b>→</b> |              |  |
| <b>π</b> <b>×</b> <b>4</b>             |              |  |
| <b>÷</b>                               |              |  |
| <b>R/S</b>                             | P=6,872.2339 | Enters value for $I$ and solves for $P$ .      |

The answer is (A).

**PROBLEM 7**

A pipe has a diameter of 100 mm at section AA and a diameter of 50 mm at section BB. The velocity of an incompressible fluid is 0.3 m/s at section AA. What is most nearly the flow velocity at section BB?

- (A) 0.95 m/s
- (B) 1.2 m/s
- (C) 2.1 m/s
- (D) 3.5 m/s

**SOLUTION 7**

Use the continuity equation (Equation 7, p. 16) and solve for  $V$ . Pressure is the same at both places; therefore, enter 1 for both  $O$  and  $P$ . The area is  $\pi r^2$  in each instance. The area can be calculated during the solution process, as shown below. Alternatively, the area can be calculated prior to entering Equation mode.

| Keys                  | Display      | Description   |
|-----------------------|--------------|---|
| <b>→</b> <b>EQN</b>   | P×A×V=O×Z×U  | Enters Equation mode. Scroll through list to bring needed equation to bottom line of display. |
| <b>SOLVE</b> <b>V</b> | P?<br>0.0000 | Starts to solve for $V$ . Prompts for $P$ and displays current value.                         |
| <b>1</b> <b>R/S</b>   | A?<br>0.0000 | Enters 1 for $P$ . Prompts for $A$ and displays current value.                                |