

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

**John A. Camara, PE**

**Professional Publications, Inc.  
Belmont, CA**

**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

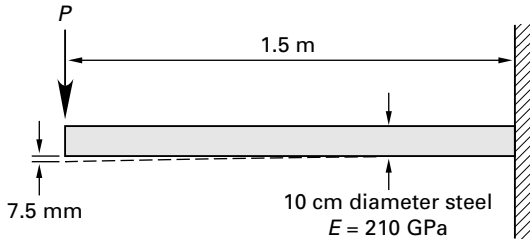
**Disciplines** General, Mechanical

**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.
	$D?$ 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.

<b>Keys</b>	<b>Display</b>	<b>Description</b>
<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? 0.0000	Starts to solve for $V$ . Prompts for $P$ and displays current value.
<b>1</b> <b>R/S</b>	A? 0.0000	Enters 1 for $P$ . Prompts for $A$ and displays current value.