## Answers to selected questions:

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Frequently asked two Number Systems:

1- Decimal Number System (base 10)
2- Binary Number System (base 2)

In Decimal System 10 different digits are used to create any number, but in Binary System only 0s and 1s are used to create any number.

<table>
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<tr>
<th>DECIMAL</th>
<th>BINARY</th>
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<tbody>
<tr>
<td>2</td>
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<tr>
<td>3</td>
<td>11</td>
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<tr>
<td>5</td>
<td>101</td>
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<tr>
<td>6</td>
<td>110</td>
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<tr>
<td>8</td>
<td>1000</td>
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<td>9</td>
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<td>10</td>
<td>1010</td>
</tr>
<tr>
<td>12</td>
<td>1100</td>
</tr>
<tr>
<td>14</td>
<td>1110</td>
</tr>
<tr>
<td>15</td>
<td>1111</td>
</tr>
<tr>
<td>19</td>
<td>10011</td>
</tr>
<tr>
<td>25</td>
<td>11001</td>
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</table>
Binary Number System:

In digital computers, binary number system (the base-2) is used. Conversions from BINARY to DECIMAL or from DECIMAL to BINARY can easily be done using the calculator. Binary (base-2), decimal (base-10).

Problem:

Find the binary equivalent of decimal 25? Here, decimal is base-10.
Turn on your calculator

1) Press MODE
2) Press “4”
3) Enter 25 and press “ = ”
4) Make sure to see 25 under Dec on the screen
5) Press SHIFT then “log”
6) Answer: 11001

Problem:

Find the decimal equivalent of binary 1111?
Turn on your calculator

1) Press MODE
2) Press “4”
3) Press SHIFT then press “log” key
4) Enter 1111 and then press “ = ”
5) Make sure to see 1111 under Bin on the screen
6) Press SHIFT then hit “ x^2 ” key
7) Answer: 15
NUMBER SYSTEMS
BINARY & DECIMAL
NCEES Reference Handbook, Page: 213

Important Keys
Problem: (Beam Deflections)

For the simple beam shown the beam weight is included in the uniform load. Determine the maximum deflection and the slope at A (in radians).

Solution: We will use NCEES-Reference Handbook, page 155 and 81.

\[ \delta_{\text{max}} = \frac{5}{384} \frac{wL^4}{EI} + \frac{1}{48} \frac{PL^3}{EI} \]

For DEFLECTIONS: \( 12^3 \)

For SLOPES: \( 12^2 \)

Finding the maximum deflection:

The maximum deflection will be at the midpoint of the span. For quick calculations when using US unit systems, architects and engineers use conversion factors like \( 12^3 \) and \( 12^2 \). For DEFLECTIONS this conversion factor is \( 12^3 \) and for SLOPES the conversion factor will be \( 12^2 \).

\[ \delta_{\text{max}} = \frac{5}{384} \frac{(2 \cdot 2)^4}{(29,000)(518)} (12^3) + \frac{1}{48} \frac{(12)(24)^3}{(29,000)(518)} (12^2) \]

\[ = 0.994 + 0.397 = 1.391 \text{ inches} \]

Finding the slope at support A:

\[ \theta_A = \frac{wL^3}{24EI} + \frac{PL^2}{16EI} = \frac{1}{24} \frac{(2.0)(24)^3}{(29,000)(518)} (12^2) + \frac{1}{16} \frac{(12)(24)^2}{(29,000)(518)} (12^2) \]

\[ = 0.01104 + 0.00414 = 0.01518 \text{ Radians} \]

\[ = 0.01518 \text{ Radians} \]
**Problem:** (Beam Deflection)

A cantilever beam is loaded as shown. Knowing that the beam weight is included in the uniform load, determine the maximum deflection.

**Solution:** We will use NCEES Ref. Handbook, Page 155 and page 82.

\[
\delta_{\text{max}} = \frac{1}{8} \frac{wL^4}{EI} + \frac{1}{3} \frac{PL^3}{EI}
\]

\[
= \frac{1}{8} \frac{(2.5)(14)^4}{(29,000)(800)} (12^3) + \frac{1}{3} \frac{(10)(14)^3}{(29,000)(800)} (12^3)
\]

\[
= 0.8942 + 0.6813
\]

\[
= 1.575 \text{ inches}
\]
Problem: (Deflections)

A cantilever beam is loaded as shown. The beam weight is included in the uniform load. Using the given cross-section and the modulus of elasticity answer the following questions:

(1) the max. deflection (in.) of the beam is most nearly ($\delta_B$)
   (A) 0.0367  
   (B) 0.4929  
   (C) 0.6525  
   (D) 1.4456

(2) the slope (rad.) at the free end of the beam is most nearly ($\theta_B$)
   (A) 0.06458  
   (B) 0.03782  
   (C) 0.00415  
   (D) 0.00596

(3) the moment at the support is most nearly ($M_A$)
   (A) 75  
   (B) 83  
   (C) 90  
   (D) 105
Problem: (Friction)

\[ W = 200 \text{ lb} \]
\[ P = 60 \text{ lb} \]
\[ \mu_s = 0.25 \]
\[ \mu_k = 0.20 \]

\[ \mu_s \] : coefficient of static friction
\[ \mu_k \] : coefficient of kinetic friction

A 60-lb force acts on a 200-lb crate on an inclined plane as shown in the figure. Using the listed data, answer the following questions:

(1) the magnitude of the friction force (lb) acting on the crate: \((F)\)

(A) 45.5  
(B) 50.0  
(C) 55.5  
(D) 60.0

(2) the magnitude of the normal force (lb) acting on the crate: \((N)\)

(A) 140  
(B) 150  
(C) 160  
(D) 180

(3) the maximum friction force (lb) acting on the crate: \((F_m)\)

(A) 32.9  
(B) 40.0  
(C) 53.5  
(D) 62.0
\textbf{Problem:} (Friction)

\[ W = 220 \text{ lb} \]
\[ P = 60 \text{ lb} \]
\[ \theta = 25^\circ \]
\[ \mu_s = 0.28 \]

\( \mu_s \) : coefficient of static friction

A 60-lb force acts on a 220-lb crate on an inclined plane as shown in the figure. Using the listed data answer the following questions:

(1) the magnitude of the friction force (lb) acting on the crate \( F \)

(A) 26.8  
(B) 30.5  
(C) 38.6  
(D) 45.4

(2) the magnitude of the normal force (lb) acting on the crate \( N \)

(A) 350  
(B) 310  
(C) 280  
(D) 225

(3) the maximum friction force (lb) acting on the crate \( F_m \)

(A) 62.9  
(B) 78.4  
(C) 83.5  
(D) 92.8
DETERMINATE FRAMES

Support Reactions

(4) FR-410

\[
\begin{align*}
A_x &= 1.0 \text{k} \\
A_y &= 15 \text{k} \\
B_y &= 9 \text{k}
\end{align*}
\]

(5) FR-A74

\[
\begin{align*}
A_x &= 0 \\
A_y &= 26.5 \text{k} \\
B_y &= 18.5 \text{k}
\end{align*}
\]

FR-63

(6) FR-A73

\[
\begin{align*}
A_x &= 6.0 \text{k} \\
A_y &= 26.75 \text{k} \\
B_y &= 29.75 \text{k}
\end{align*}
\]
DETERMINATE FRAMES
Support Reactions

(1)
FR-232-C

Answers

\[ A_x = 24 \, \text{k} \]
\[ A_y = 9 \, \text{kip} \]
\[ B_y = 15 \, \text{kip} \]

(2)
FR-355

Answers

\[ A_x = 32.0 \, \text{k} \]
\[ A_y = 9.33 \, \text{kip} \]
\[ B_y = 30.67 \, \text{k} \]

(3)
FR-356

Answers

\[ A_x = 24.0 \, \text{k} \]
\[ A_y = 6.5 \, \text{k} \]
\[ B_y = 17.5 \, \text{k} \]
**Problem:** (Frame with internal hinge)

The frame shown has an internal pin at C. Using the given load and support conditions, answer the following questions:

1. the vertical support reaction (kN) at the left support, $A_y$
   - (A) 3.26
   - (B) 4.86
   - (C) 5.44
   - (D) 6.75

2. the horizontal support reaction (kN) at the left support, $A_x$
   - (A) 5.48
   - (B) 6.15
   - (C) 7.34
   - (D) 8.86

3. the vertical support reaction (kN) at the right support, $B_y$
   - (A) 5.22
   - (B) 6.34
   - (C) 7.14
   - (D) 8.20

4. the magnitude of the axial load (kN) in $AC$ is most nearly, $N_{AC}$
   - (A) 1.00
   - (B) 1.43
   - (C) 2.05
   - (D) 2.65