FUNDAMENTALS OF ENGINEERING

CIVIL EXAM TOPICS

Computer-Based Test (CBT)

Total Number of Questions: 110

Time: 6 hours

The new Civil FE Computer-Based Test (CBT) consists of 110 multiple-choice questions (Each problem only one question) the examinee will have 6 hours to complete the test.

- **Mathematics (Approx. 9 questions*)**
- **Probability and Statistics (5 questions)**
- **Computational Tools (5 questions)**
- **Ethics and Professional Practice (5 questions)**
- **Engineering Economics (5 questions)**
- **Statics (9 questions)**
- **Dynamics (5 questions)**
- **Mechanics of Materials (9 questions)**
- **Civil Engineering Materials (5 questions)**
- **Fluid Mechanics (5 questions)**
- **Hydraulics and Hydrologic Systems (10 questions)**
- **Structural Analysis (8 questions)**
- **Structural Design (8 questions)**
- **Geotechnical Engineering (12 questions)**
- **Transportation Engineering (10 questions)**
- **Environmental Engineering (8 questions)**

* Here the number of questions are the average values taken from the NCEES Reference Handbook (Version 9.1 / Computer-Based Test)

ROOTS OF EQUATIONS

MATHEMATICS

NCEES Reference Handbook / Page-265

$$F(x) = \frac{x^3 + 4x^2 + x - 6}{x + 2}$$

The roots of the above function $F(x)$ are most nearly

(A) +1, -2, +3

(B) -1, +2

➡ (C) +1, -3

(D) +1, +2, -3

Solution:

After factoring and simplification:

$$F(x) = \frac{(x-1)(x \not+ 2)(x+3)}{(x \not+ 2)}$$

$$(x-1)(x+3) = 0$$

First Root = + 1

Second Root = - 3

MATH-724
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ROOTS OF EQUATIONS

MATHEMATICS

NCEES Reference Handbook / Page-265

(1)

$$F(x) = \frac{x^3 - 2x^2 - 5x + 6}{x - 3}$$

The roots of the above function $F(x)$ are most nearly

(A) +1, -2, +3
(B) -1, +2
(C) +1, -2
(D) +1, +2, -3

(2)

$$F(x) = \frac{x^3 + 3x^2 - 10x - 24}{x + 4}$$

The roots of the above function $F(x)$ are most nearly

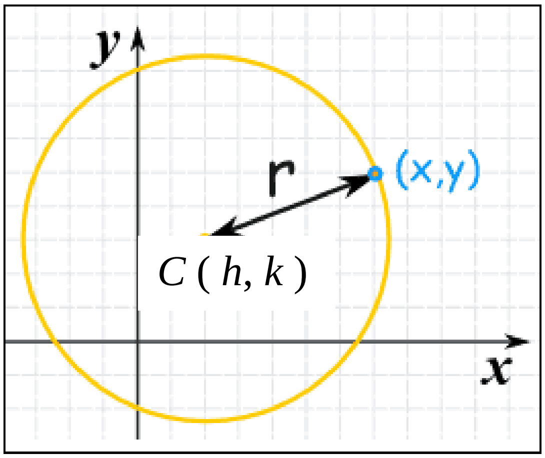
(A) +1, -2
(B) -2, +3
(C) +3, -4
(D) +2, -3, +4

FUNDAMENTALS OF ENGINEERING

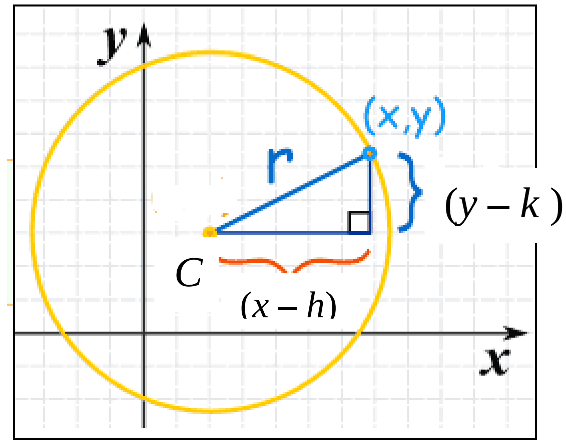
DOMAIN: MATHEMATICS

CIRCLE EQUATIONS

(NCEES-Ref Handbook / Page-23)



Center: $C\ (h, k)$



Radius: r

Standard form of a Circle Equation:

$$(x - h)^2 + (y - k)^2 = r^2$$

$$r = \text{SQRT}\ (x - h)^2 + (y - k)^2$$

Example:

The equation of a circle with center at *C* (-7, 9) and a radius of 5 is:

(A) $(x - 7)^2 + (y - 9)^2 = 5$

(B) $(x + 7)^2 + (y - 9)^2 = 5$

(C) $(x - 7)^2 + (y + 9)^2 = 25$

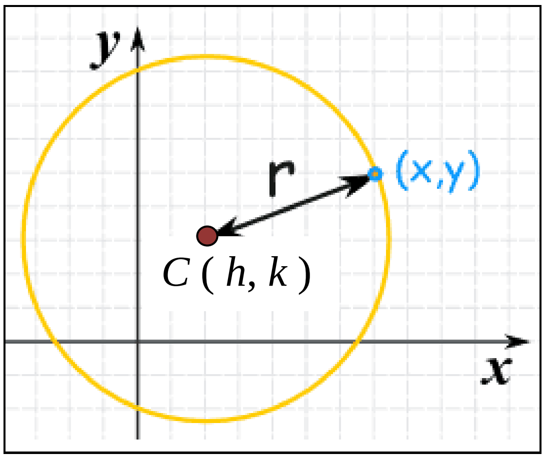
⇨ (D) $(x + 7)^2 + (y - 9)^2 = 25$

FUNDAMENTALS OF ENGINEERING

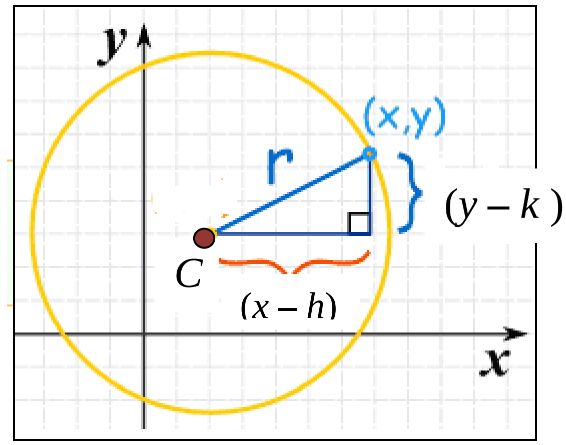
DOMAIN: MATHEMATICS

EQUATION OF A CIRCLE

(NCEES-Ref Handbook / Page-23)



Center: $C\ (h, k)$



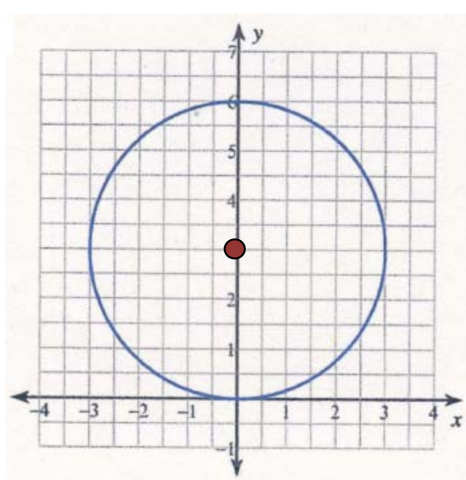
Radius: r

Standard form of Equation of a Circle

$$(x - h)^2 + (y - k)^2 = r^2$$

$$r = \text{SQRT}\ (x - h)^2 + (y - k)^2$$

Example:



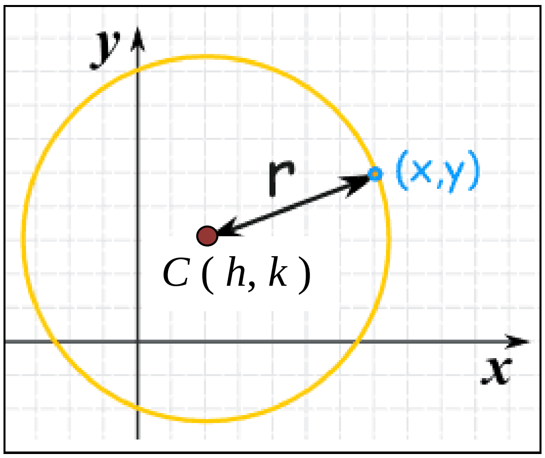
$$x^2 + (y-3)^2 = 9$$

FUNDAMENTALS OF ENGINEERING

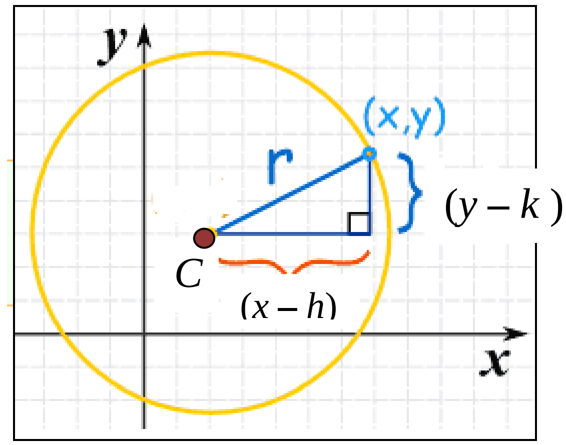
MATHEMATICS

EQUATION OF A CIRCLE (Standard Form)

NCEES-Reference Handbook / Page-23



Center: $C\ (h, k)$



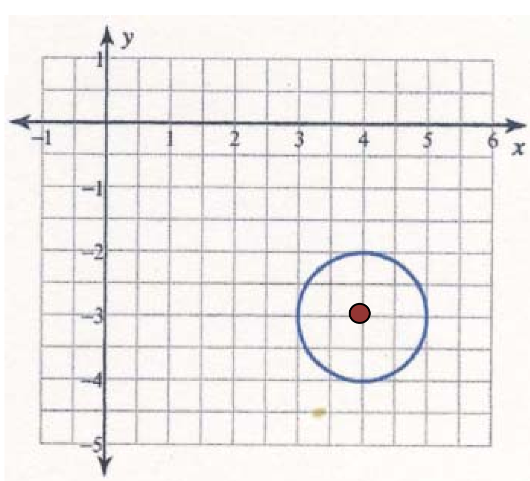
Radius: r

Standard form of Equation of a Circle

$$(x-h)^2 + (y-k)^2 = r^2$$

$$r = \text{SQRT}\ (x-h)^2 + (y-k)^2$$

Example:



Center: $C\ (4, -3)$

$$(x-4)^2 + (y+3)^2 = 1$$

Problem: (Matrix Algebra)

$$A = \begin{bmatrix} 3 & -3 & 2 \\ 2 & 5 & -3 \\ 3 & -1 & 1 \end{bmatrix}$$

Using the matrix given above, answer the following questions:

(1) the determinant of the above matrix is most nearly

(A) 4
➡ (B) 5
(C) 6
(D) 8

(2) the inverse of matrix **A** is most nearly, (A^{-1})

(A) $$A^{-1} = \begin{bmatrix} 1/4 & 1/4 & -1/4 \\ 10/4 & 5/4 & 13/4 \\ -10/4 & -4/4 & 11/4 \end{bmatrix}$$

(B) $$A^{-1} = \begin{bmatrix} 2/3 & 1/3 & -1/6 \\ -11/3 & -7/3 & 13/3 \\ -17/3 & -8/3 & 32/3 \end{bmatrix}$$

(C) $$A^{-1} = \begin{bmatrix} 2/5 & 1/5 & 1/5 \\ 11/5 & 3/5 & 13/5 \\ -17/5 & -6/5 & 21/5 \end{bmatrix}$$

➡ (D) $$A^{-1} = \begin{bmatrix} 2/5 & 1/5 & -1/5 \\ -11/5 & -3/5 & 13/5 \\ -17/5 & -6/5 & 21/5 \end{bmatrix}$$

FUNDAMENTALS OF ENGINEERING

DOMAIN: MATHEMATICS

MATRICES & DETERMINANTS

NCEES-Reference Handbook / Pages 30-31

$$\mathbf{A} = \begin{bmatrix} 2 & -3 \\ 1 & -1 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 1 & 2 & -0 \\ 2 & -5 & -2 \end{bmatrix}$$

Using the matrices given above, answer the following questions:

(1) the determinant of the matrix **A** is most nearly

- (A) 4
- (B) -3
- (C) -2
- (D) 1

(2) the matrix product of **A** and **B** is most nearly, **A*B**

(A) $$A*B = \begin{bmatrix} -4 & 12 & -10 \\ 2 & -5 & -2 \end{bmatrix}$$

(B) $$A*B = \begin{bmatrix} -1 & 12 & -4 \\ 0 & -5 & -2 \end{bmatrix}$$

(C) $$A*B = \begin{bmatrix} -4 & 19 & 6 \\ -1 & 7 & 2 \end{bmatrix}$$

(D) $$A*B = \begin{bmatrix} -2 & 11 & -20 \\ 2 & 13 & 7 \end{bmatrix}$$

Problem: (Compound Interest)

A sum of $10,000 is deposited in a savings account and left there to earn interest for 10 years. If the interest rate per year is 8% the compound amount after 10 years is most nearly:

(A) 18, 546
(B) 21,589
(C) 24,576
(D) 27,368

$F = ?$

NCEES - Ref. Handbook
Page 132, Factor Table
i = 8.00 %

Problem: (Compound Interest)

A student wants to pay off a current debt of $2,500 in three years. Knowing that the interest rate is 6 % compounded annually, the amount that must be paid at the end of the third year is most nearly:

(A) 3,254
(B) 3,152
(C) 2,978
(D) 2,874

$F = ?$

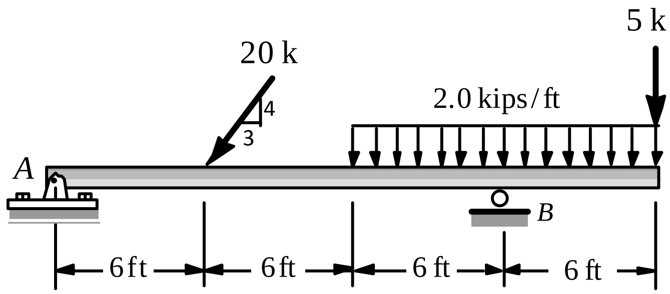
NCEES - Ref. Handbook
Page 131, Factor Table
i = 6.00 %

FUNDAMENTALS OF ENGINEERING

STATICS

BEAM SUPPORT REACTIONS

NCEES-Reference Handbook / Page-63



A determinate beam is loaded as shown. Knowing that *A* is a pin support and *B* is a roller, answer the following questions:

(1) The horizontal support reaction (kips) at *A* is most nearly:

(A) 10.00
(B) 11.25
➡ (C) 12.00
(D) 15.00

A_x = ?

(2) The vertical support reaction (kips) at B is most nearly:

(A) 48.55
(B) 44.00
(C) 42.30
➡ (D) 36.00

B_y = ?

(3) The vertical support reaction (kips) at *A* is most nearly:

(A) 8.00
➡ (B) 9.00
(C) 10.50
(D) 12.30

A_y = ?

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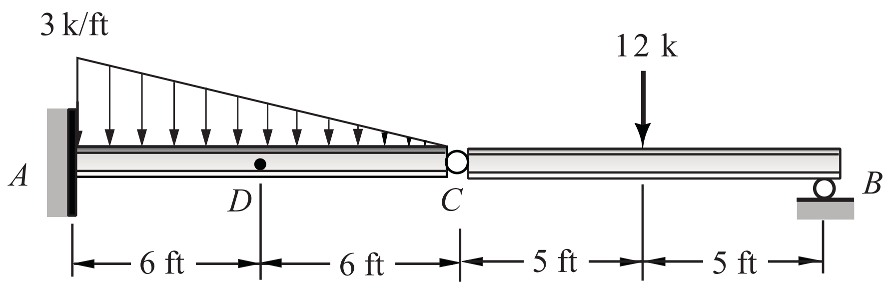
BEAMS WITH INTERNAL HINGES

DOMAIN: STATICS



Joint *C* : Pin

Support *A* : Fixed
Support *B* : Roller

Two beams are connected with an internal pin at C as shown. Using the given loads and the support conditions, determine the following:

(1) the vertical support reaction (kips) at support *B*

(A) 4.50
(B) 4.75
(C) 5.00
(D) 6.00

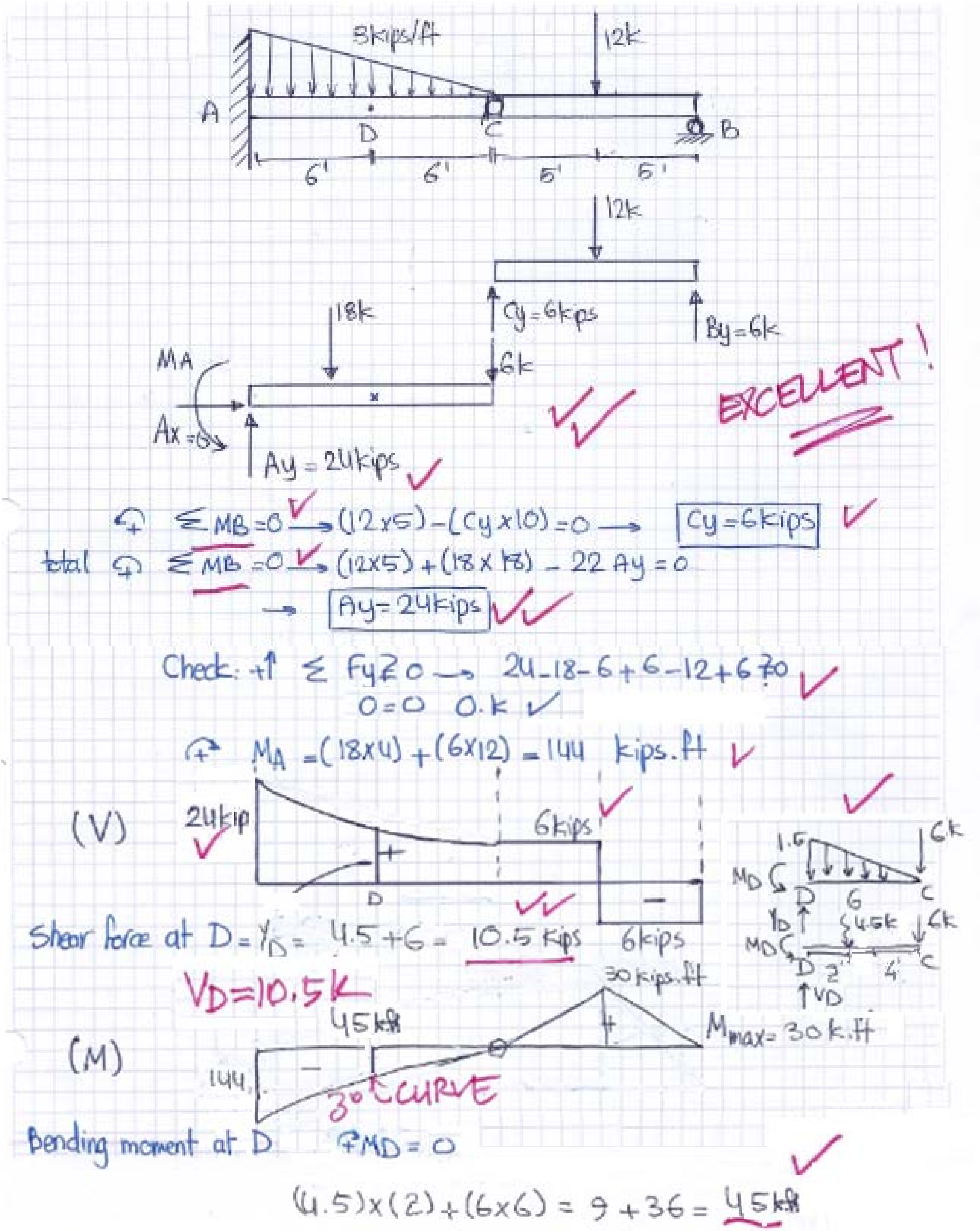
(2) the bending moment (ft-kips) at support *A*

(A) 238
(B) 214
(C) 144
(D) 124

(3) the bending moment (ft-kips) at point *D*

(A) 48
(B) 45
(C) 36
(D) 30

BEAMS WITH INTERNAL HINGES



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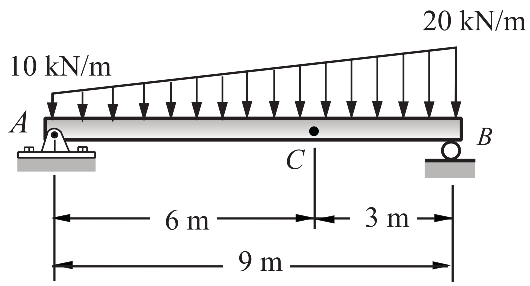
ZEYTINCI
FALL 2013

Problem: (Determinate Beams)



FE/PE EXAM

Support A : Pin
Support B : Roller

The dimensions and loading of a simple beam are given as shown. Using the listed data, answer the following questions:

(1) the support reaction (kN) at support A is most nearly

- (A) 60
- (B) 65
- (C) 70
- (D) 85

(2) the support reaction (kN) at right support B is most nearly

- (A) 85
- (B) 75
- (C) 65
- (D) 90

(3) the internal shear (kN) at point C is most nearly

- (A) +30.0
- (B) + 20.0
- (C) -30.0
- (D) -20.0

(4) the bending moment (kN.m) at point C is most nearly

- (A) 120
- (B) 130
- (C) 140
- (D) 150

BM-119
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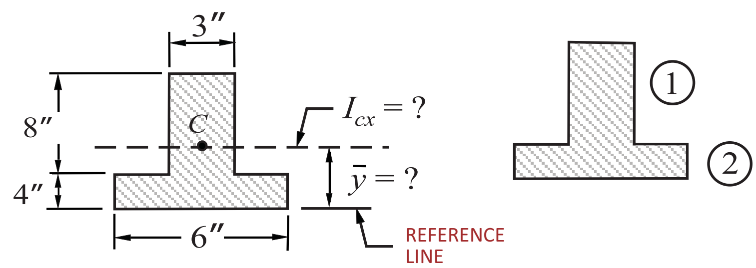
FALL 2014

Centroid / Moments of Inertia



Centroid Calculations

	A_i	y_i	$A_i\, y_i$
	in.^{2}	in.	in.^{3}
1	24.00	8.0	192.00
2	24.00	2.0	48.00
Σ	**48.00**	—	**240.00**

$$\bar{y} = \frac{\Sigma A_i\, y_i}{\Sigma A_i} = \frac{240}{48} = 5.0 \text{ in.}$$

Moments of Inertia

	I_o	A_i	d_i	$A_i d_i^2$
	in.^{4}	in.^{2}	in.	in.^{4}
1	128.0	24.00	3.00	216.00
2	32.00	24.00	3.00	216.00
Σ	**160.00**		—	**432.00**

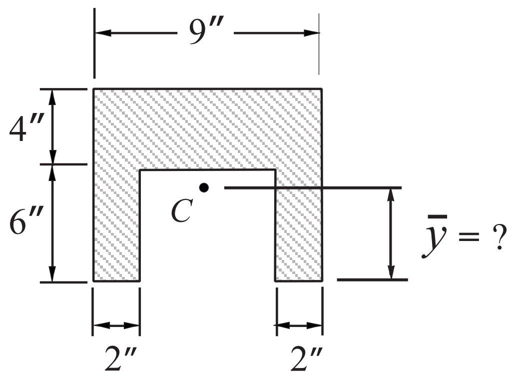
$$I_{xc} = \Sigma I_o + \Sigma A_i \,.\, d_i^{\,2} = 160.0 + 432.0 = 592 \text{ in.}^4$$

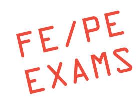
$$I_{yc} = I_{y1} + I_{y2} = 18.0 + 72.0 = 90.0 \text{ in.}^4$$

FUNDAMENTALS OF ENGINEERING

DOMAIN: STATICS

NCEES Reference Handbook / Page 63





The dimensions of a composite area are given as shown in the figure. Using the listed data answer the following questions:

(1) the distance $\bar{y}$ (in.) of the centroid is most nearly

(A) 7.30
(B) 7.82
(C) 6.75
(D) 6.00

$\bar{y} = ?$

(2) the moment of inertia (in.^4) about the horizontal centroidal axis is most nearly (I_{cx})

(A) 642
(B) 504
(C) 480
(D) 395

$I_{cx} = ?$

(3) the moment of inertia (in.^4) about the vertical centroidal axis is most nearly (I_{cy})

(A) 468
(B) 545
(C) 648
(D) 735

$I_{cy} = ?$

Answers
1- (D)
2- (C)
3- (B)

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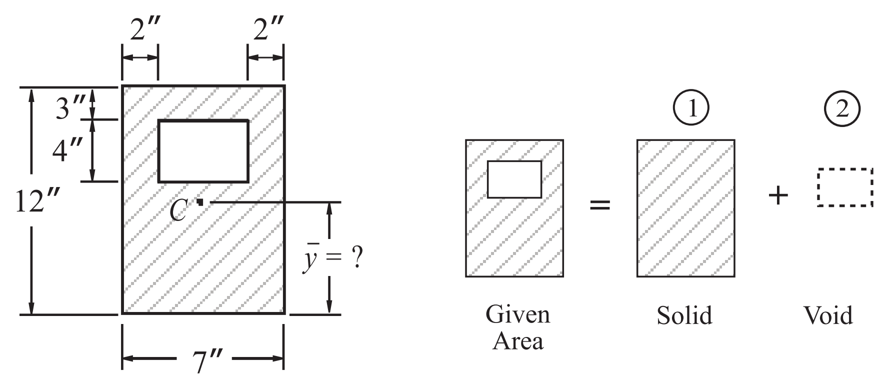
SPRING 2014

Centroid / Moments of Inertia



Centroid Calculations

	A_i	y_i	$A_i\, y_i$
	in.^{2}	in.	in.^{3}
1	84.00	6.0	504.00
2	-12.00	7.0	-84.00
Σ	**72.00**	—	**420.00**

$$\bar{y} = \frac{\Sigma A_i\, y_i}{\Sigma A_i} = \frac{420}{72} = 5.83 \text{ in.}$$

Moments of Inertia Calculations

	I_o	A_i	d_i	$A_i d_i^2$
	in.^{4}	in.^{2}	in.	in.^{4}
1	1008	84.00	0.17	2.43
2	-16.00	-12.00	1.17	-16.43
Σ	**992.0**		—	**-14.00**

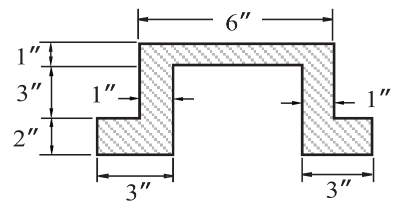
$$I_{cx} = \Sigma I_o + \Sigma A_i \,.\, d_i^{\,2} = 992 - 14 = 978 \text{ in.}^4$$

$$I_{cy} = I_{y1} + I_{y2} = \frac{12 \text{ x} 7^3}{12} - \frac{4 \text{ x } 3^3}{12} = 343 - 9 = 334 \text{ in.}^4$$

CENTROIDS / MOMENTS OF INERTIA

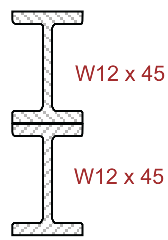
PARTIAL ANSWERS FOR SUPPLEMENTAL PROBLEMS

1- DEF-59



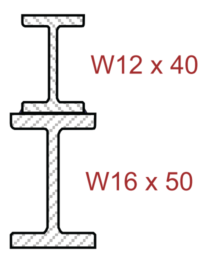
$\bar{y}$ = 2.75 in.
I_{cx} = 94.5 in.^{4}

2- DEF-77



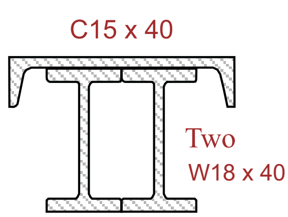
$\bar{y}$ = 12.1 in.
I_{cx} = 1655 in.^{4}

3- DEF-87



$\bar{y}$ = 14.40 in.
I_{cx} = 2261 in.^{4}

4- DEF-91



$\bar{y}$ = 11.85 in.
I_{cx} = 1827 in.^{4}

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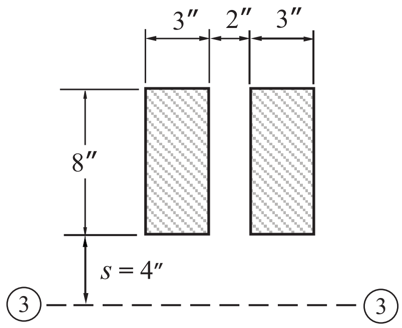
CENTROIDS / MOMENTS OF INERTIA

SUPPLEMENTAL PROBLEMS

MORE PAT APPLICATIONS

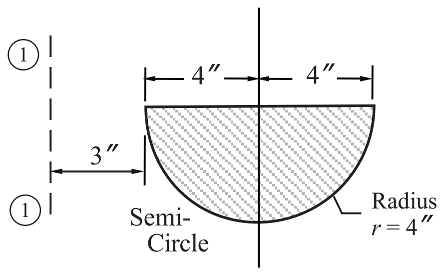
1-



I_{cx} = ... in.^{4}

$I_{3\text{-}3}$ = 3328 in.^{4}

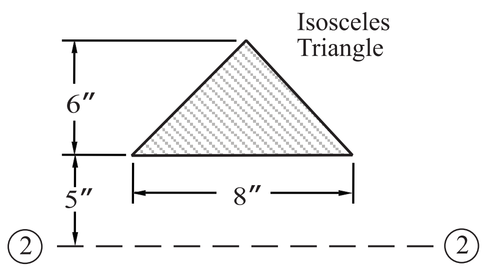
2-



I_{cx} = ... in.^{4}

$I_{1\text{-}1}$ = 1332 in.^{4}

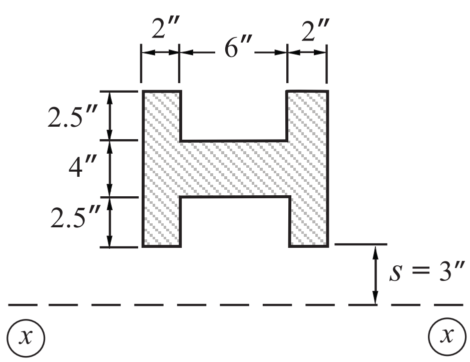
3-



I_{cx} = ... in.^{4}

$I_{2\text{-}2}$ = 1224 in.^{4}

4-



I_{cx} = 275 in.^{4}

$I_{x\text{-}x}$ = 3650 in.^{4}

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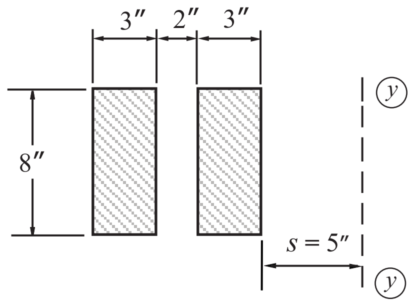
CENTROIDS / MOMENTS OF INERTIA

SUPPLEMENTAL PROBLEMS

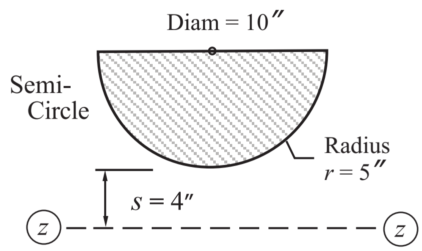
MORE PAT APPLICATIONS

5-



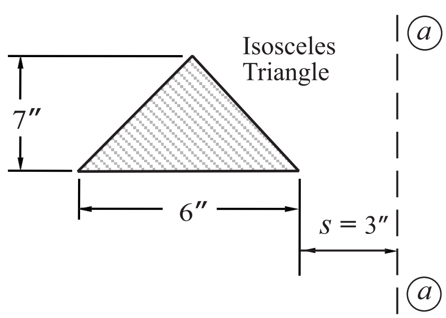
I_{cx} = 336 in.^{4}
$I_{y\text{-}y}$ = 4224 in.^{4}

6-



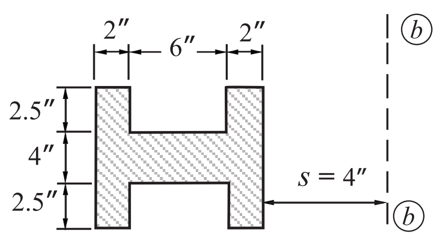
I_{cx} = ... in.^{4}
$I_{z\text{-}z}$ = 1927 in.^{4}

7-



I_{cy} = 31.5 in.^{4}
$I_{a\text{-}a}$ = 787.5 in.^{4}

8-



I_{cy} = ... in.^{4}
$I_{b\text{-}b}$ = 5520 in.^{4}