

OCTOBER 2015

DR. Z's CORNER

**Conquering the FE & PE exams
Examples & Applications**

Starting This Month

*As you all may know **ASCE-NCS eNewsletter** and **Dr.Z's Corner** is read by many engineering students, practicing engineers and others not only in the U.S. but around the globe. With October 2015 edition of **ACSE-NCS eNewsletter**, we begin a new monthly feature inviting prominent academicians, engineers and professionals from industry to volunteer and join forces with us. We will ask them to contribute to **Dr. Z's Corner** and share their experiences with our readers. Each month they will volunteer to submit to this column their own original problems with solutions or answers related to the FE and PE exams in their disciplines. We hope our readers will enjoy reviewing the work of these professionals and learn from them.*

This month's guest contributor is Dr. Vagelis Plevris, an engineering professor from Europe and a world renowned scholar in structural engineering. His brief career highlights is also included at the end of this section.

ENGINEERING ECONOMICS PROBLEMS

FUTURE WORTH & PRESENT WORTH

The simplest problems to solve in engineering economic analysis are those which involve finding the value of a single amount of money at an earlier or later date than that which is given. Such problems involve finding the **future worth (F)** of a specified **present amount (P)**, or vice versa. These problems involve using the following two equations:

$$F = P (1 + i)^n$$

$$P = F (1 + i)^{-n}$$

F: future sum of money

P: present sum of money

i: interest rate (%)

n: time (period), mostly years

Standard factor notations

$$F = P (F/P, i, n) = P \cdot (Factor)$$

$$P = F (P/F, i, n) = F \cdot (Factor)$$

Tabulated Interest Factors (NCEES-Reference Handbook)

i = 0.5%, 1.0%, 1.5%, 2.0%, 4%, 6%, 8%, 10%, 12%, 18%

i = **1.5%** and **2%** (NCEES-RH / Page 133)

i = **4%** and **6%** (NCEES-RH / Page 134)

i = **8%**, **10%** (NCEES-RH / Page 135)

i = **12%**, **18%** (NCEES-RH / Page 136)

ENGINEERING ECONOMY

INTEREST TABLES

NCEES-Reference Handbook Version 9.3 / Computer-Based Testing

$i = 0.5\%, 1.0\%, 1.5\%, 2.0\%, 4\%, 6\%, 8\%, 10\%, 12\%, 18\%$

$i = 1.5\%$ and 2% (NCEES-RH / Page 133)

$i = 4\%$ and 6% (NCEES-RH / Page 134)

$i = 8\%, 10\%$ (NCEES-RH / Page 135)

$i = 12\%, 18\%$ (NCEES-RH / Page 136)

Reference Handbook
9.3 Version for Computer-Based Testing

FUNDAMENTALS OF ENGINEERING

ENGINEERING ECONOMICS

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 135, 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 134, Factor Table
 $i = 6.00\%$

FUNDAMENTALS OF ENGINEERING

ENGINEERING ECONOMICS

Problem: (Future worth / Semiannual Compounding)

James deposits \$500 into a savings account that pays 6 % compounded semiannually. How much would be in the account at the end of one year?

- (A) \$515.25
- (B) \$ 530.45
- (C) \$ 550.30
- (D) \$ 585.40

$$F = ?$$

Problem: (Future worth / Daily Compounding) HK

Christi deposits \$10,000 into a savings account that pays 12 % compounded daily. How much would be in the account after four years?

- (A) \$13,356
- (B) \$ 14,245
- (C) \$ 15,530
- (D) \$ 16,160

$$F = ?$$

FUNDAMENTALS OF ENGINEERING

ENGINEERING ECONOMICS

Problem: (Time Period / Semiannual Compounding)

Stacey invested her savings at 3% per 6-month period (semiannually). She wants to know the number of years required for her money to double in amount?

- (A) \$15.6
- (B) \$13.4
- (C) \$12.3
- (D) \$11.7

$$n = ?$$

Problem: (Monthly Payments / Monthly Compounding)

Kevin wants to buy a computer for \$2,400. He has decided to save a uniform amount at the end of each month so that he will have the required \$2,400 at the end of one year. Knowing that his bank pays 6% interest compounded monthly, how much does he have to deposit each month?

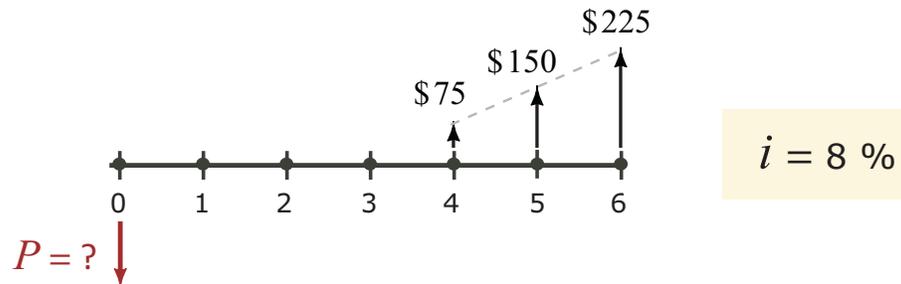
- (A) \$215
- (B) \$195
- (C) \$188
- (D) \$179

$$A = ?$$

FUNDAMENTALS OF ENGINEERING

ENGINEERING ECONOMICS

Problem: (Uneven cash flow stream) / W

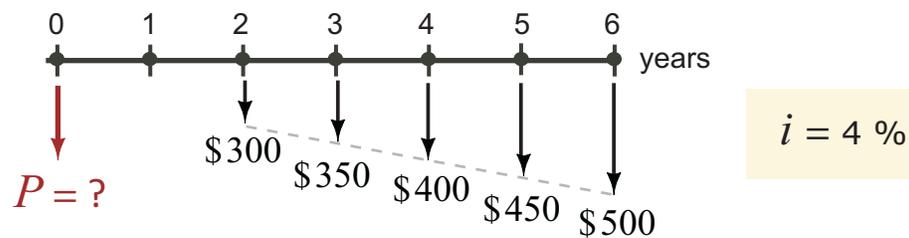


An uneven cash flow diagram (CFD) is given as shown above. Knowing that the interest rate is 8% compounded annually the present worth P is most nearly?

- (A) \$250
- (B) \$299
- (C) \$337
- (D) \$440

$P = ?$

Problem: (Uneven cash flow stream) / W



An uneven cash flow diagram (CFD) is given as shown above. Knowing that the interest rate is 4% compounded annually the present worth P is most nearly?

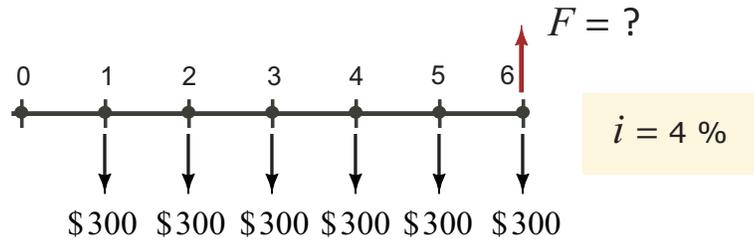
- (A) \$1,250
- (B) \$1,695
- (C) \$1,835
- (D) \$1,956

$P = ?$

FUNDAMENTALS OF ENGINEERING

ENGINEERING ECONOMICS

Problem: (Uniform Series / Sinking Fund) / W



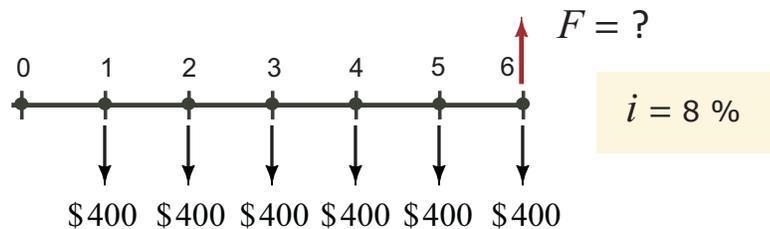
David deposits \$300 in a savings account at the end of each year for six years. The CFD is constructed as shown in the figure. Knowing that the interest rate is 4% compounded annually, the accumulated amount at the end of six years, immediately after the sixth deposit, is most nearly?

- (A) \$ 1850
- (B) \$ 1990
- (C) \$ 2200
- (D) \$ 2345

$F = ?$

NCEES-RH
Page-134

Problem: (Uniform Series / Sinking Fund) / W



Suzan deposits \$ 400 in a savings account at the end of each year for six years. The CFD is constructed as shown in the figure. Knowing that the interest rate is 8 % compounded annually, the accumulated amount at the end of six years, immediately after the sixth deposit, is most nearly?

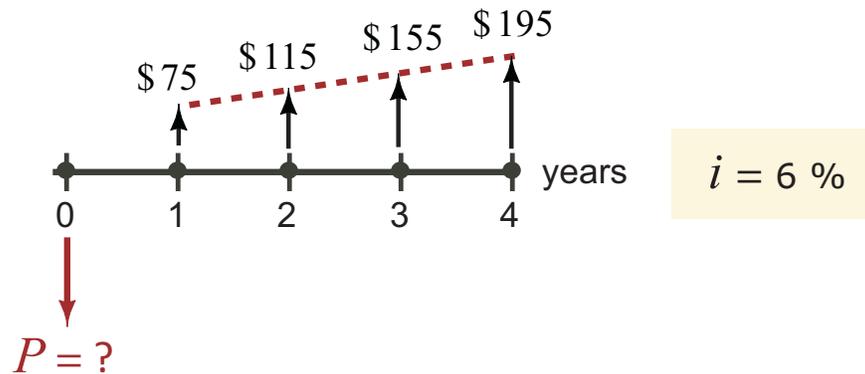
- (A) \$ 1850
- (B) \$ 1990
- (C) \$ 2200
- (D) \$ 2934

$F = ?$

NCEES-RH
Page-135

FUNDAMENTALS OF ENGINEERING
ENGINEERING ECONOMICS

Problem: (Uneven cash flow stream) / W



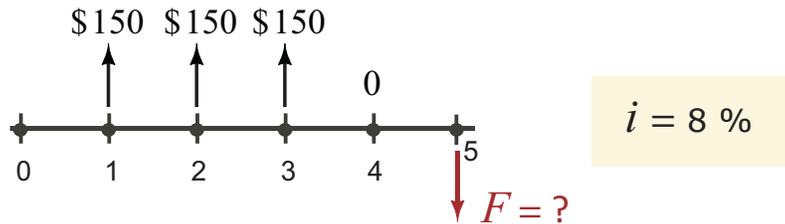
An uneven cash flow diagram (*CFD*) is given as shown above. Knowing that the interest rate is 6 % compounded annually the present worth P is most nearly?

- (A) \$280
- (B) \$395
- (C) \$458
- (D) \$490

$P = ?$

FUNDAMENTALS OF ENGINEERING
ENGINEERING ECONOMICS

Problem: (Future Worth) / W



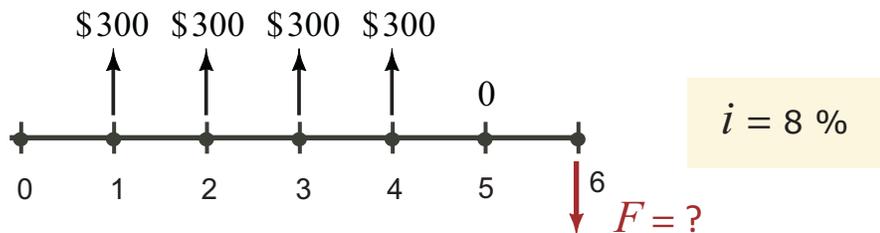
A cash flow diagram (CFD) is given as shown above. Knowing that the interest rate is 8 % compounded annually the future worth F is most nearly?

- (A) \$ 855
- (B) \$ 663
- (C) \$ 568
- (D) \$426

$F = ?$

NCEES-RH
Page-135

Problem: (Future Worth) / W



A cash flow diagram (CFD) is given as shown above. Knowing that the interest rate is 8 % compounded annually the future worth F is most nearly?

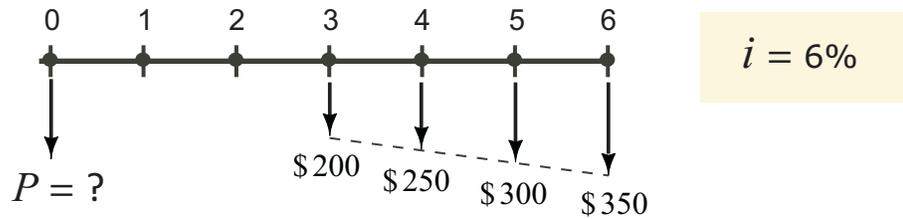
- (A) \$ 1455
- (B) \$ 1577
- (C) \$ 1768
- (D) \$1826

$F = ?$

NCEES-RH
Page-135

FUNDAMENTALS OF ENGINEERING
ENGINEERING ECONOMICS

Problem: (w)



A cash flow diagram (CFD) is given as shown above. Knowing that the interest rate is $i = 6\%$ compounded annually, answer the following question:

The present worth (P) is most nearly:

- (A) \$ 598.67
- (B) \$ 650.25
- (C) \$ 765.45
- (D) \$ 836.87

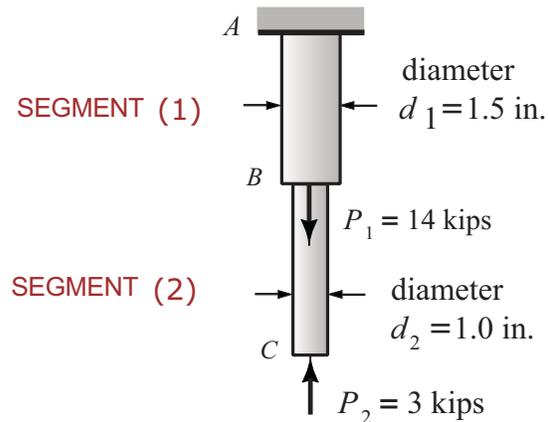
$P = ?$

NCEES-RH
Page-134

FUNDAMENTALS OF ENGINEERING

MECHANICS OF MATERIALS

Problem: (Axial Load)



A stepped rod with circular cross-section is subjected to the axial loads as shown in the figure. Using the listed data answer the following:

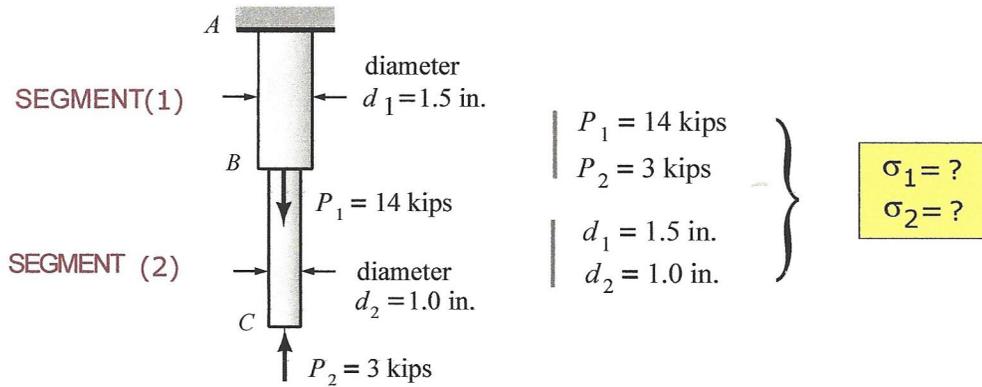
(1) The axial stress (psi) in segment #1 is most nearly:

- (A) 3,500 (C)
- (B) 4,250 (T)
- (C) 5,360 (C)
- (D) 6,220 (T)

(2) The axial stress (psi) in segment #2 is most nearly:

- (A) 2,120 (C)
- (B) 3,820 (C)
- (C) 4,440 (C)
- (D) 5,000 (T)

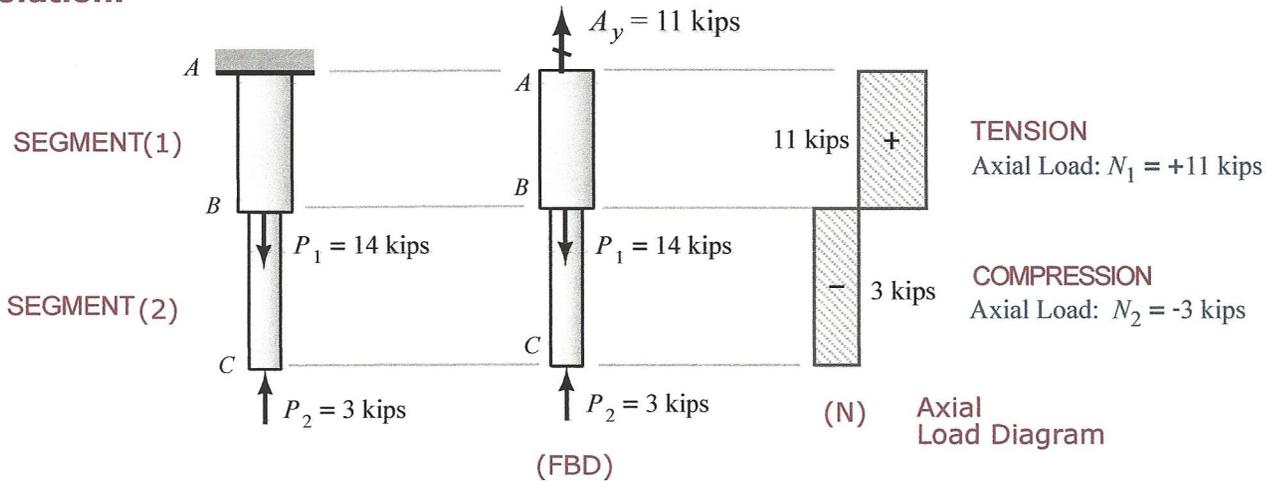
Problem: (Axial Load)



A stepped rod with circular cross-section is subjected to the loads as shown in the figure. Using the listed data answer the following:

- (a) find the support reaction at A
- (b) draw the axial load diagram
- (c) determine the axial stress in each segment

Solution:



Cross-sectional areas (A_i)

$$A_1 = \pi d_1^2 / 4 = \pi (1.5^2) / 4 = 1.767 \text{ in}^2$$

$$A_2 = \pi d_2^2 / 4 = \pi (1.0^2) / 4 = 0.785 \text{ in}^2$$

Support Reaction: (A_y)

Using the vertical equilibrium equation

$$+\uparrow \Sigma F_y = 0; \quad A_y - 14 + 3 = 0$$

$$A_y = 11 \text{ kips} \quad \uparrow$$

Axial Stress in each segment (σ_i)

$$\sigma_1 = \frac{N_1}{A_1} = \frac{+11,000}{1.767} = +6,220 \text{ psi (tension)}$$

$$\sigma_2 = \frac{N_2}{A_2} = \frac{-3,000}{0.785} = -3,820 \text{ psi (comp)}$$

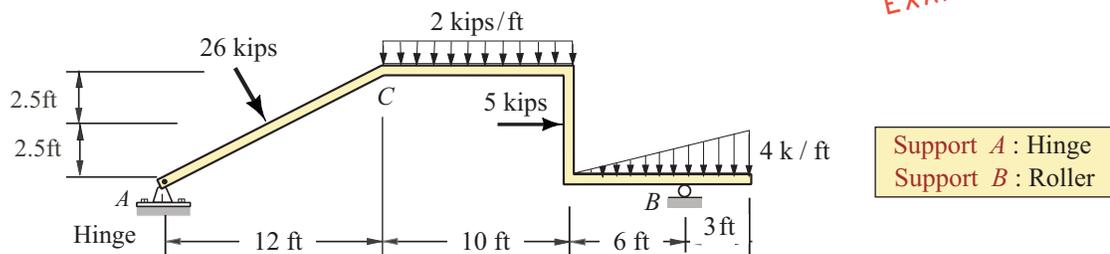
Answers:

$$\sigma_1 = 6,220 \text{ psi (tension)}$$

$$\sigma_2 = -3,820 \text{ psi (comp)}$$

DETERMINATE FRAMES

FE/PE
EXAM



The determinate frame is loaded as shown in the figure. Using the given loads and the support conditions, answer the following questions:

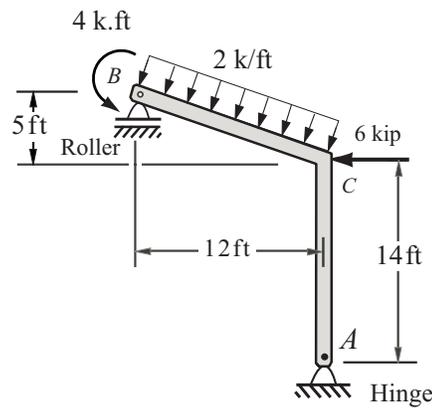
- (1) The horizontal support reaction (kips) at the left support, A_x
 - (A) 30.0
 - (B) 25.4
 - (C) 20.5
 - (D) 15.0

- (2) The vertical support reaction (kips) at the left support, A_y
 - (A) 18.26
 - (B) 25.37
 - (C) 34.45
 - (D) 43.52

- (3) The vertical support reaction (kips) at the right support, B_y
 - (A) 61.26
 - (B) 55.18
 - (C) 42.75
 - (D) 36.63

- (4) The bending moment (k-ft) at joint C is most nearly, M_C
 - (A) 210
 - (B) 280
 - (C) 325
 - (D) 360

Problem: (Determinate Frames)



FE/PE
EXAM

Support A : Hinge
Support B : Roller

The determinate frame is loaded as shown in the figure. Using the given loads and the support conditions, answer the following questions:

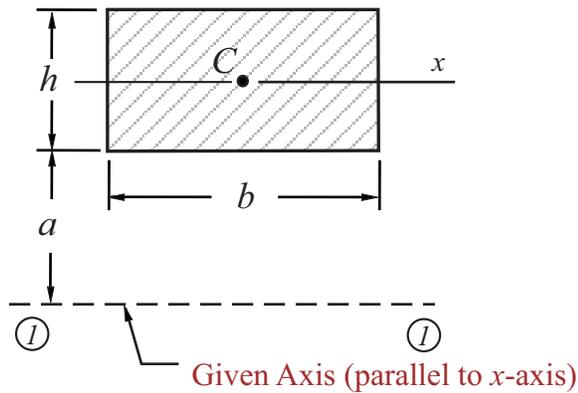
- (1) The magnitude of the horizontal support reaction (kips) at A, A_x
 - (A) 12.0
 - (B) 14.0
 - (C) 15.0
 - (D) 16.0

- (2) The magnitude of the vertical support reaction (kips) at A, A_y
 - (A) 9.08
 - (B) 8.00
 - (C) 7.54
 - (D) 6.26

- (3) The magnitude of the vertical support reaction (kips) at B, B_y
 - (A) 43.25
 - (B) 33.08
 - (C) 26.70
 - (D) 24.06

- (4) The magnitude of the bending moment (k-ft) at joint C is most nearly, M_C
 - (A) 173
 - (B) 194
 - (C) 212
 - (D) 224

PARALLEL AXIS THEOREM



PAT | Parallel Axis Theorem

- (a) Moment of inertia about the x axis ($I_{cx} = ?$)
 (b) Moment of inertia about the (1-1) axis ($I_{1-1} = ?$)

Formulas:

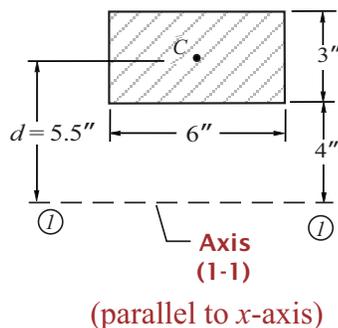
$$I_{cx} = \frac{bh^3}{12}$$

$$I_{1-1} = I_{cx} + A \cdot d^2 \quad \text{PAT}$$

- I_{cx} = Moment of inertia about the centroidal x axis
- I_{1-1} = Moment of inertia about axis (1-1)
- A = Area ($A = b \cdot h$)
- d = Distance from the centroid to the axis (1-1)

$$d = a + h/2$$

Example:



$$I_{cx} = \frac{bh^3}{12} = \frac{(6)(3)^3}{12} = 13.50 \text{ in.}^4$$

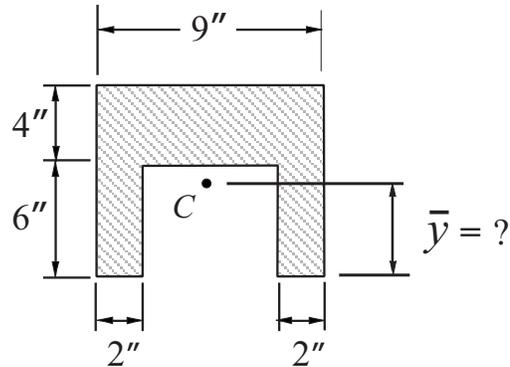
$$A = bh = (6)(3) = 18 \text{ in.}^2$$

$$d = 4 + \frac{3}{2} = 5.5 \text{ in.}$$

$$I_{1-1} = I_{cx} + A \cdot d^2 = 13.50 + (18)(5.5)^2 = 558 \text{ in.}^4$$

$$I_{1-1} = 558 \text{ in.}^4$$

FUNDAMENTALS OF ENGINEERING
CENTROIDS & MOMENTS OF INERTIA
 NCEES Reference Handbook / Page 66



FE/PE
EXAMS

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

$$I_{cy} = ?$$

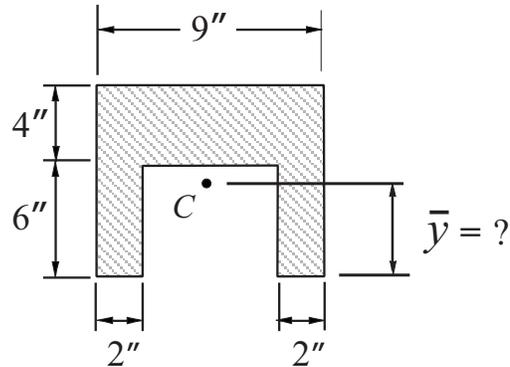


ANSWERS

FUNDAMENTALS OF ENGINEERING

CENTROIDS & MOMENTS OF INERTIA

NCEES Reference Handbook / Page 66



ANSWERS

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

$$I_{cy} = ?$$



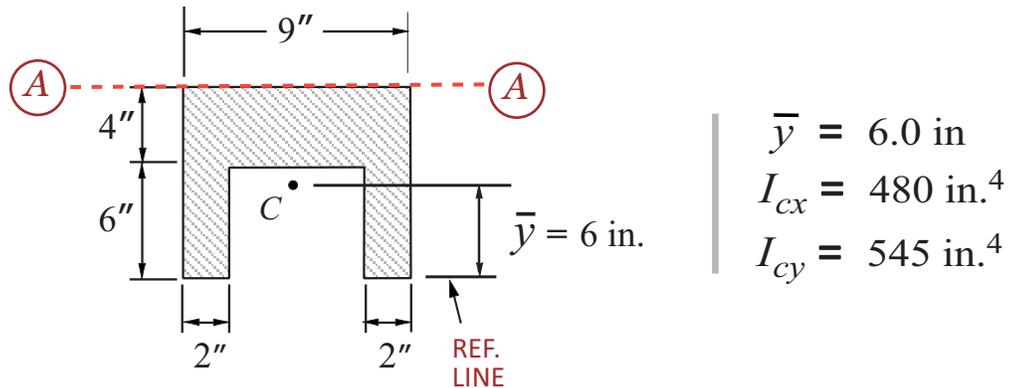
Answers

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

FUNDAMENTALS OF ENGINEERING

CENTROIDS & MOMENTS OF INERTIA

Problem: (Centroid / Moments of Inertia)



\bar{y} : The distance for the centroid from the reference line.
 I_{cx}, I_{cy} : The moment of inertia about the horizontal & vertical centroidal axes

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

(1) The moment of inertia (in.⁴) about the (A-A) axis is most nearly:

- (A) 1100
- (B) 1440
- (C) 1975
- (D) 2550

$$I_{A-A} = ?$$

(2) The minimum centroidal radius of gyration (in.) is most nearly:

- (A) 1.78
- (B) 2.15
- (C) 2.32
- (D) 2.83

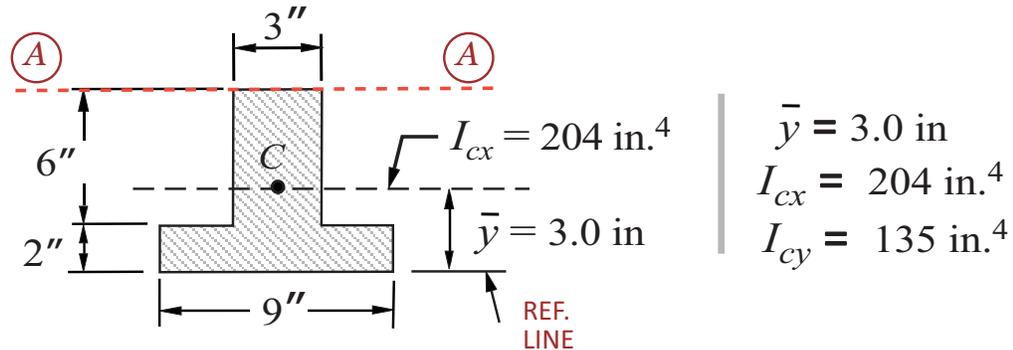
$$r_{\min} = ?$$

This problem was submitted by Dr. Vagelis Plevris, P.E., Professor
 School of Pedagogical & Technological Education, Athens, Greece

FUNDAMENTALS OF ENGINEERING

CENTROIDS & MOMENTS OF INERTIA

Problem: (Centroid / Moments of Inertia)



\bar{y} : The distance for the centroid from the reference line.
 I_{cx}, I_{cy} : The moment of inertia about the horizontal & vertical centroidal axes

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

(1) The moment of inertia (in.^4) about the (A-A) axis is most nearly:

- (A) 2815
- (B) 2216
- (C) 1275
- (D) 1104

$$I_{A-A} = ?$$

(2) The minimum *centroidal* radius of gyration (in.) is most nearly:

- (A) 1.94
- (B) 2.25
- (C) 2.73
- (D) 2.90

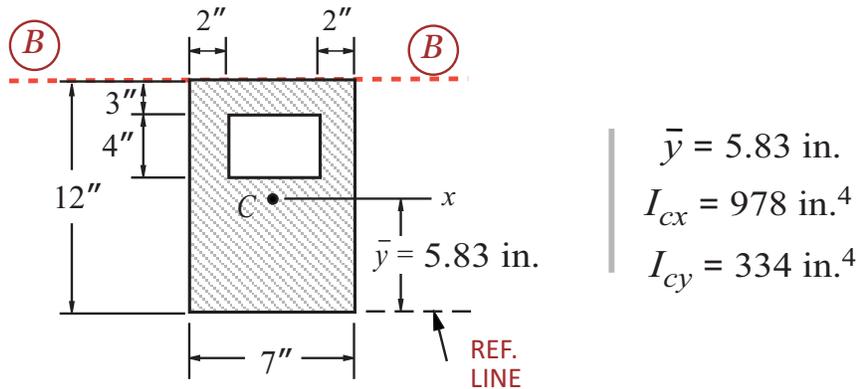
$$r_{\min} = ?$$

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FUNDAMENTALS OF ENGINEERING

CENTROIDS & MOMENTS OF INERTIA

Problem: (Centroid / Moments of Inertia)



\bar{y} : The distance for the centroid from the reference line.
 I_{cx}, I_{cy} : The moment of inertia about the horizontal & vertical centroidal axes

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

(1) The moment of inertia (in.⁴) about the (A-A) axis is most nearly:

- (A) 2800
- (B) 3716
- (C) 4275
- (D) 4550

$$I_{A-A} = ?$$

(2) The minimum *centroidal* radius of gyration (in.) is most nearly:

- (A) 1.98
- (B) 2.15
- (C) 2.62
- (D) 2.98

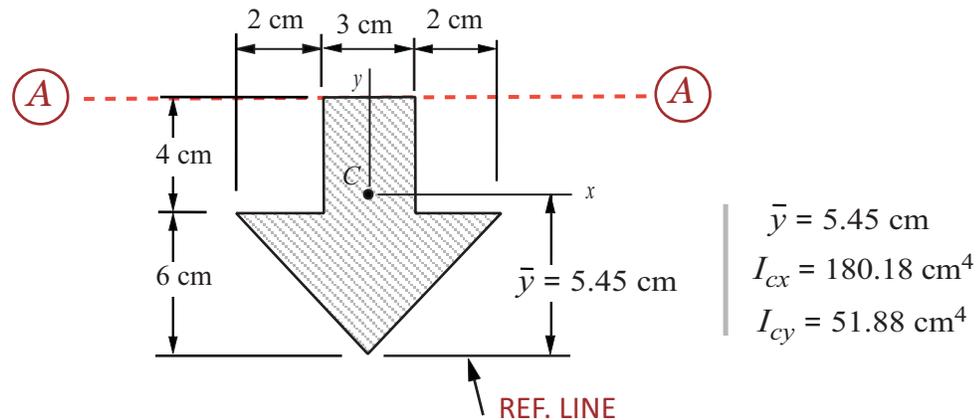
$$r_{\min} = ?$$

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 School of Pedagogical & Technological Education, Athens, Greece

FUNDAMENTALS OF ENGINEERING

CENTROIDS & MOMENTS OF INERTIA

Problem: (Centroid / Moments of Inertia)



\bar{y} : The distance for the centroid from the reference line.
 I_{cx}, I_{cy} : The moment of inertia about the horizontal & vertical centroidal axes

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

(1) The moment of inertia (cm^4) about the (A-A) axis is most nearly:

- (A) 680
- (B) 715
- (C) 862
- (D) 925

$$I_{A-A} = ?$$

(2) The minimum *centroidal* radius of gyration (cm) is most nearly:

- (A) 1.25
- (B) 2.30
- (C) 2.80
- (D) 3.25

$$r_{\min} = ?$$

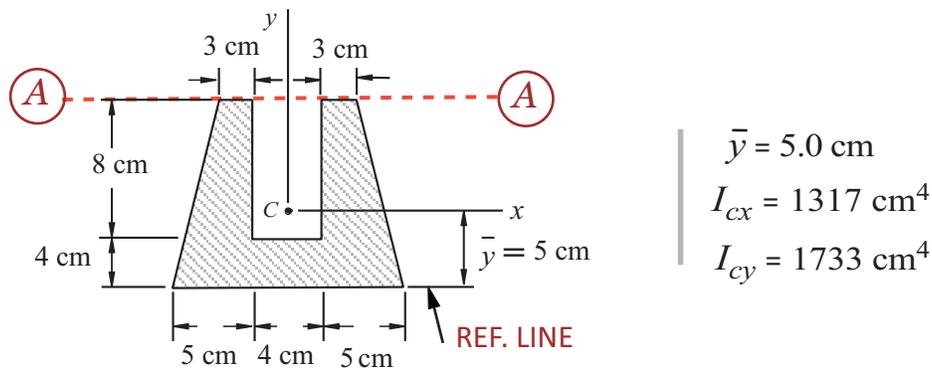
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FUNDAMENTALS OF ENGINEERING

CENTROIDS & MOMENTS OF INERTIA

NCEES Reference Handbook / Page 66

Problem: (Centroid / Moments of Inertia)



\bar{y} : The distance for the centroid from the reference line.
 I_{cx}, I_{cy} : The moment of inertia about the horizontal & vertical centroidal axes

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

(1) The moment of inertia (cm^4) about the (A-A) axis is most nearly:

- (A) 6805
- (B) 6150
- (C) 5275
- (D) 4325

$$I_{A-A} = ?$$

(2) The minimum *centroidal* radius of gyration (cm) is most nearly:

- (A) 1.90
- (B) 2.26
- (C) 2.87
- (D) 3.43

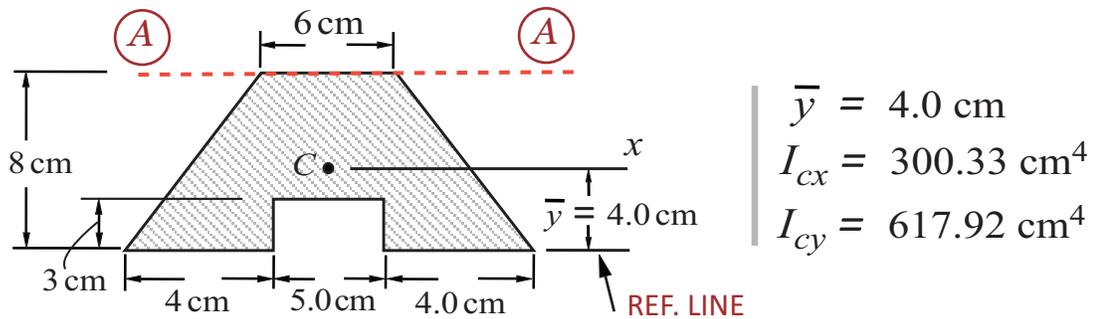
$$r_{\min} = ?$$

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FUNDAMENTALS OF ENGINEERING

CENTROIDS & MOMENTS OF INERTIA

Problem: (Centroid / Moments of Inertia)



\bar{y} : The distance for the centroid from the ref. line
 I_{cx}, I_{cy} : The moment of inertia about the horizontal & vertical centroidal axes

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

(1) The moment of inertia (cm^4) about the (A-A) axis is most nearly:

- (A) 1066
- (B) 1150
- (C) 1275
- (D) 1325

$$I_{A-A} = ?$$

(2) The minimum *centroidal* radius of gyration (cm) is most nearly:

- (A) 1.95
- (B) 2.22
- (C) 2.80
- (D) 3.25

$$r_{\min} = ?$$

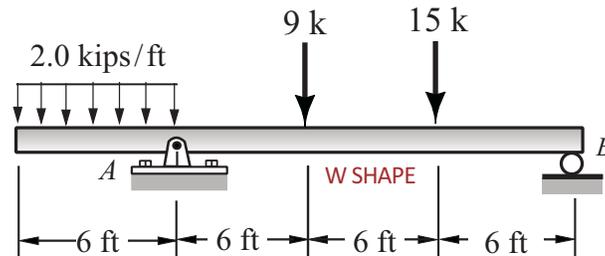
This problem was submitted by Dr. Vagelis Plevris, P.E., Professor
 School of Pedagogical & Technological Education, Athens, Greece

FUNDAMENTALS OF ENGINEERING

DETERMINATE BEAMS

Problem:

FE/PE
EXAM



Support A : Hinge
Support B : Roller

A determinate beam is loaded as shown. Using the given support conditions, answer the following questions:

(1) The left support reaction (kips) is most nearly (A_Y)

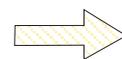
- (A) 11
- (B) 18
- (C) 22
- (D) 25

$$A_Y = ?$$

(2) The maximum moment (ft-k) is most nearly (M_{\max})

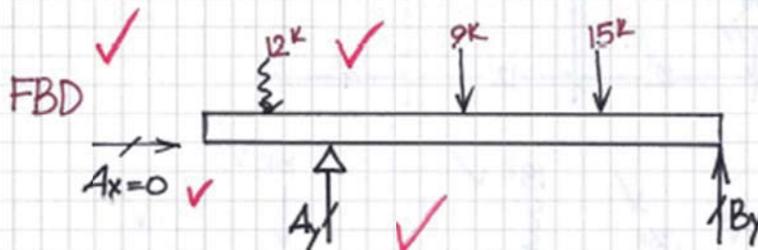
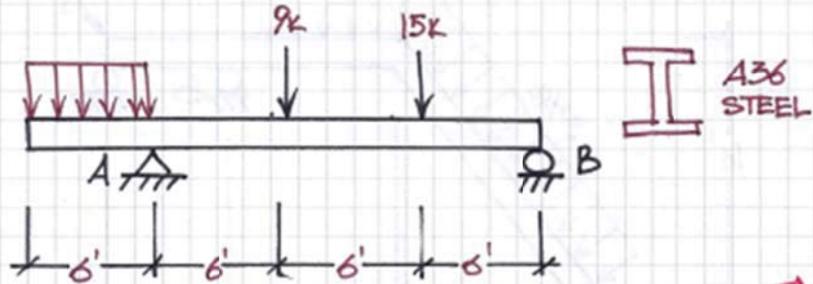
- (A) 74
- (B) 66
- (C) 60
- (D) 56

$$M_{\max} = ?$$



COMPLETE
SOLUTION

PROBLEM-3.



EXCELLENT
AZ!

$$\textcircled{1} \sum M_A = 0$$

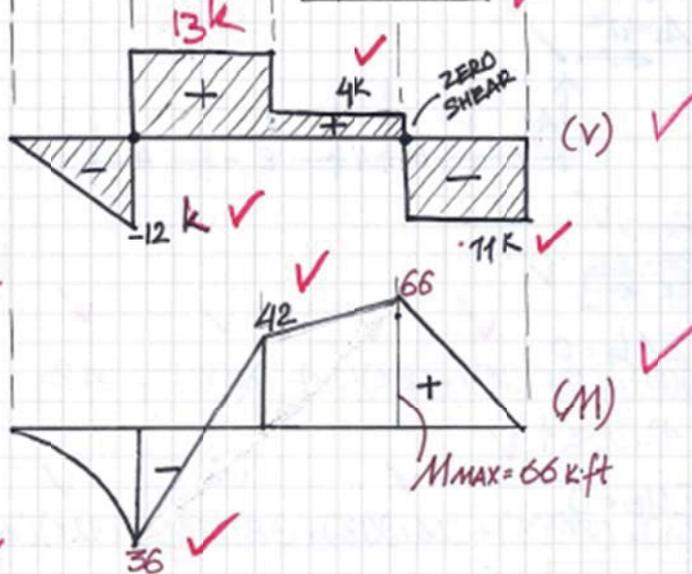
$$-(12k)(3') + (9k)(6') + (15k)(12') = 18B_y$$

$$B_y = 11k \uparrow$$

$$\textcircled{2} \sum M_B = 0$$

$$(15k)(6') + (9k)(12') + (12k)(21') = 18A_y$$

$$A_y = 25k \uparrow$$



PERFECT
SOLUTION

$$A36 = \sigma_y = 36 \text{ ksi}$$

$$\sigma_{\text{allow}} = \frac{2}{3} \sigma_y = 24 \text{ ksi}$$

$$S = \frac{M_{\text{MAX}}}{\sigma_{\text{allow}}} = \frac{66 \cdot 12}{24} = 33 \text{ in}^3$$

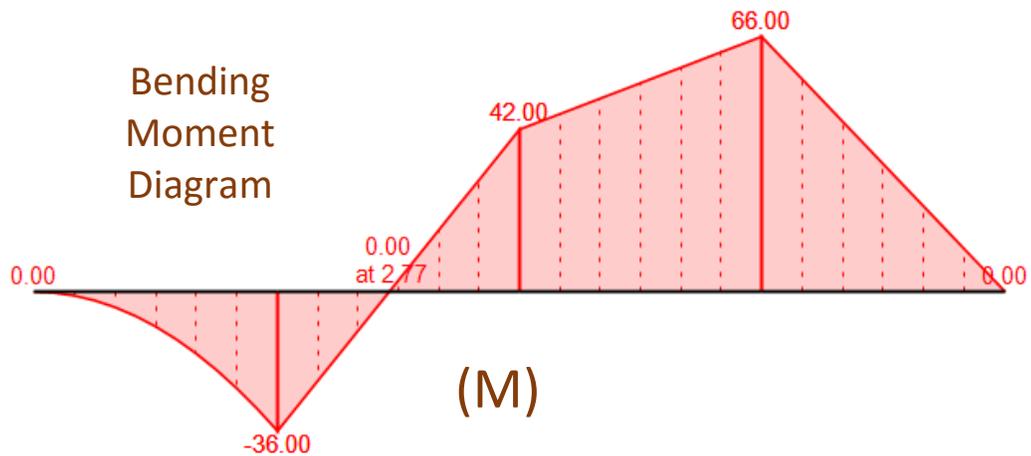
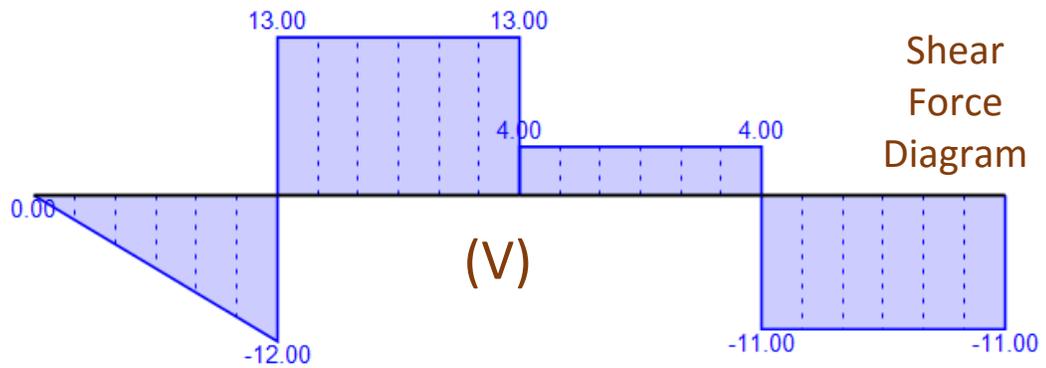
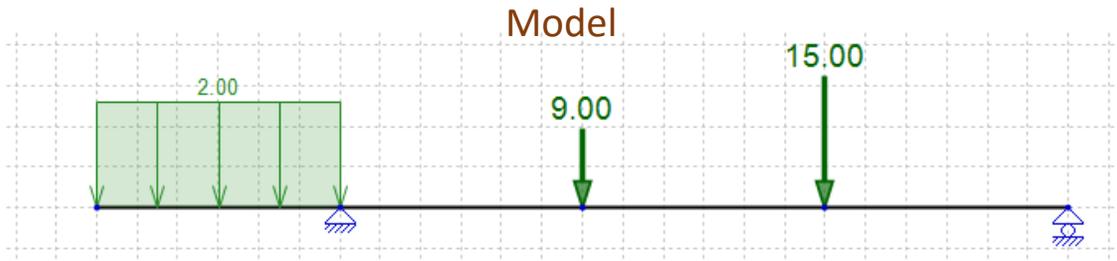
$$\Rightarrow W = 12 \times 30 \quad (S = 38.6 \text{ in}^3)$$

$$W = 14 \times 30 \quad (S = 42.0 \text{ in}^3)$$

$$W = 16 \times 30 \quad (S = 38.4 \text{ in}^3)$$

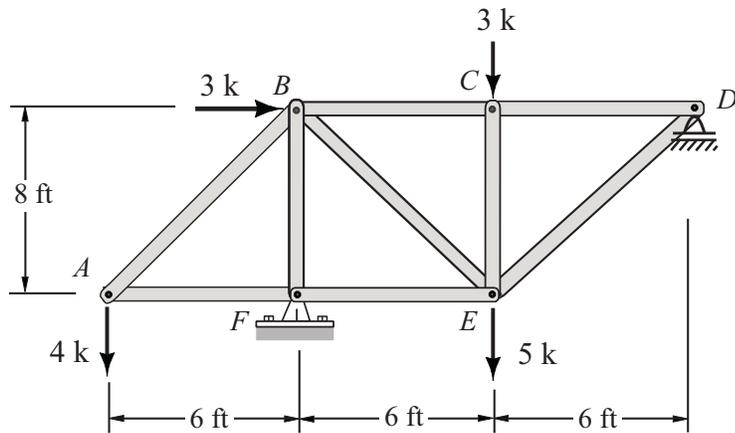
$$W = 10 \times 33 \quad (S = 35 \text{ in}^3)$$

Solution by Dr. Vagelis Plevris



FUNDAMENTALS OF ENGINEERING

Plane Truss Analysis



FE/PE
EXAM

Support A : Hinge
Support D : Roller

A determinate truss is loaded as shown. Using the given support conditions, answer the following questions:

(1) The member force in member BC is most nearly (F_{BC})

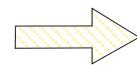
- (A) 2 kips (C)
- (B) 3 kips (C)
- (C) 2 kips (T)
- (D) 3 kips (T)

$$F_{BC} = ?$$

(2) The member force in member BE is most nearly (F_{BE})

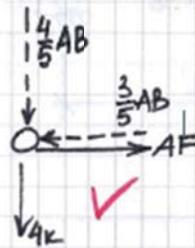
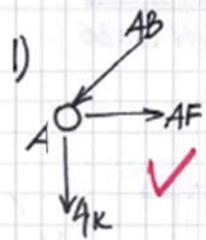
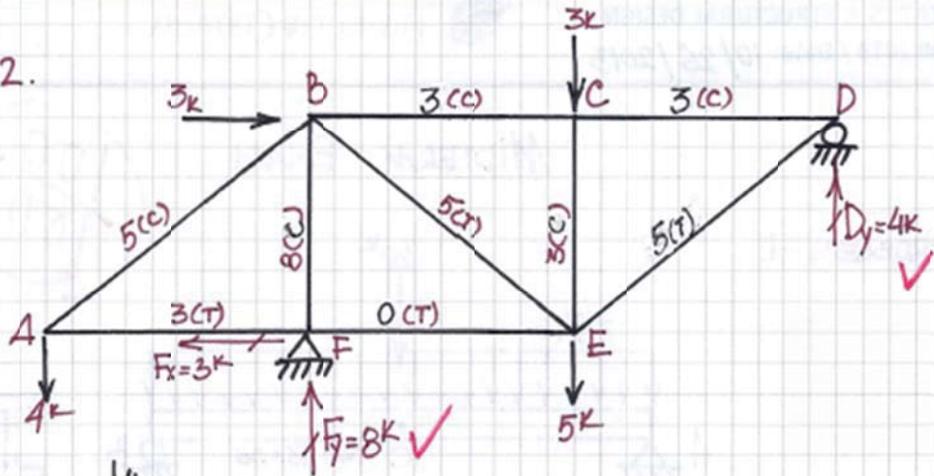
- (A) 4 kips (C)
- (B) 5 kips (C)
- (C) 4 kips (T)
- (D) 5 kips (T)

$$F_{BE} = ?$$



COMPLETE
SOLUTION

PROBLEM-2.



$$1) \uparrow \sum F_y = 0$$

$$-\frac{4}{5}AB - 4k = 0$$

$$-0.8AB = 4$$

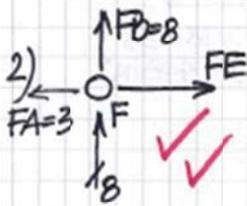
$$F_{AB} = 5(c)$$

$$2) \rightarrow \sum F_x = 0$$

$$-\frac{3}{5}AB = -AF$$

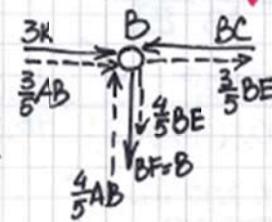
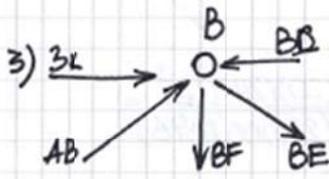
$$-\frac{3}{5}(5) = -AF$$

$$F_{AF} = 3(t)$$



$$1) \rightarrow \sum F_x = 0$$

$$F_{FE} = 0(t)$$



$$1) \uparrow \sum F_y = 0$$

$$\left(\frac{4}{5}\right)(5) - 8 - \frac{4}{5}BE = 0$$

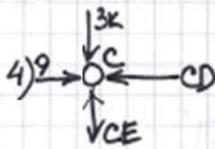
$$4 - 8 = \frac{4}{5}BE$$

$$F_{BE} = 5(t)$$

$$2) \rightarrow \sum F_x = 0$$

$$3k + \frac{3}{5}(5) - \frac{3}{5}(5) = BC$$

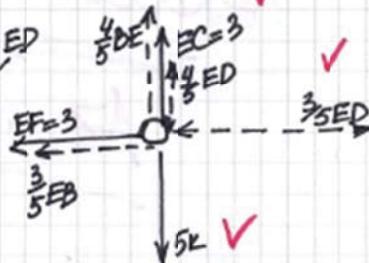
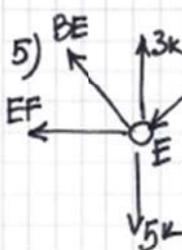
$$F_{BC} = 3(c)$$



$$\uparrow \sum F_y = 0$$

$$+3 = CE$$

$$F_{CE} = 3(t)$$



$$1) \rightarrow \sum F_x = 0$$

$$-\frac{2}{5}EB + \frac{3}{5}ED = 0$$

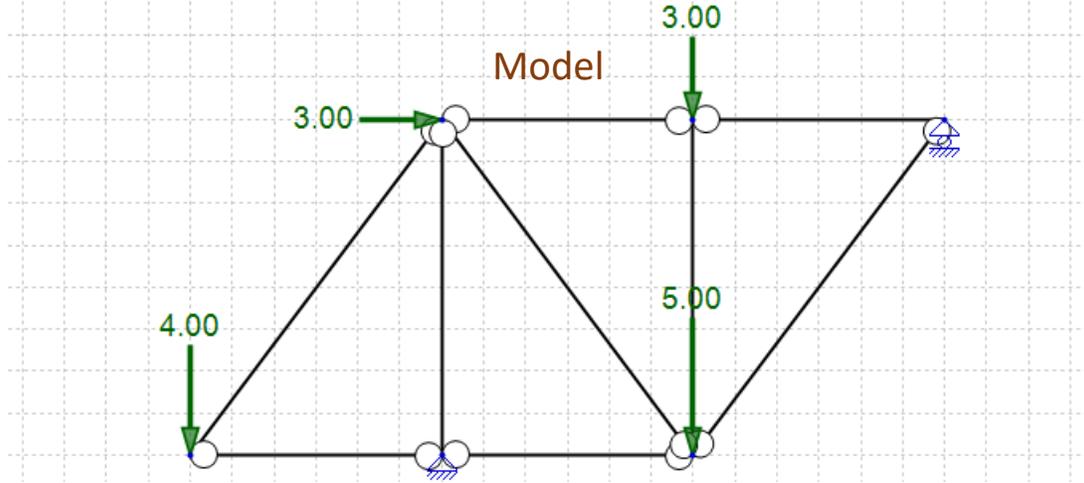
$$-3 = \frac{3}{5}ED$$

$$-3/0.6 = FED$$

$$F_{ED} = 5(t)$$

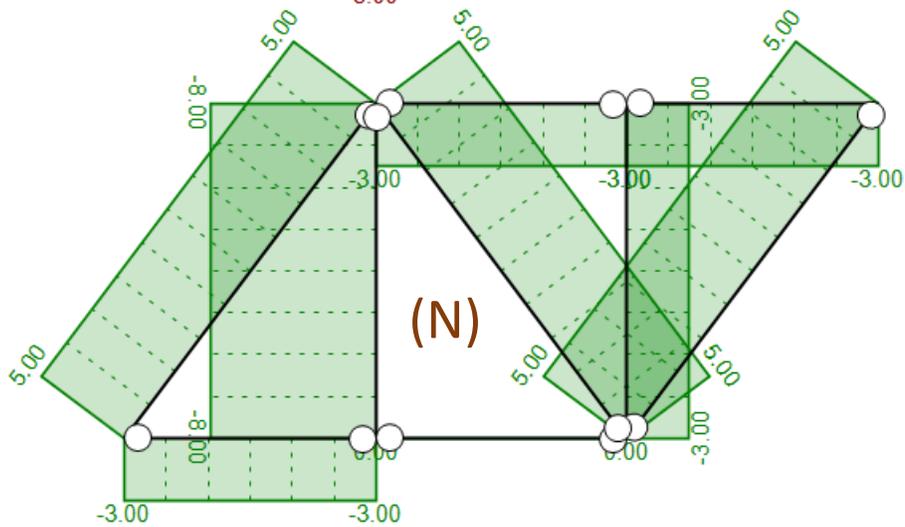
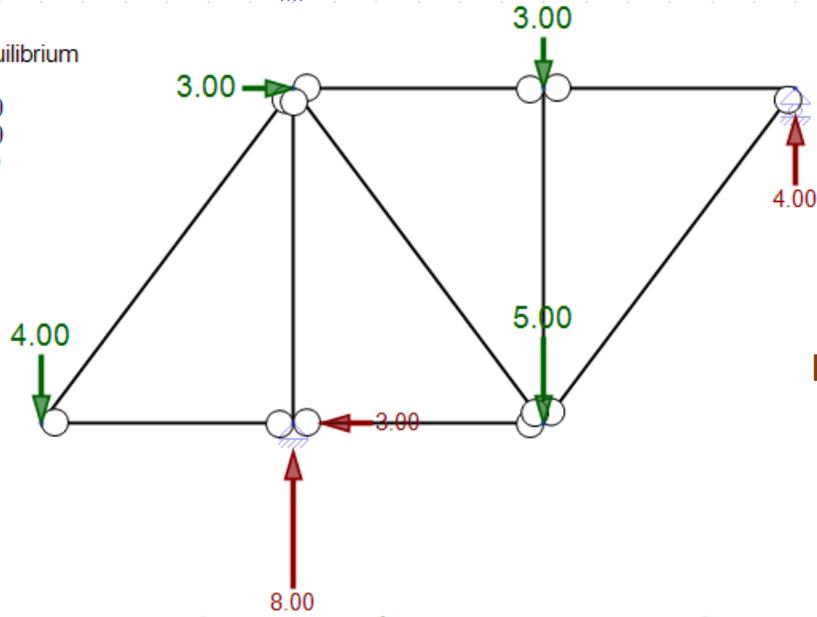
EXCELLENT

Solution by Dr. Vagelis Plevris



Model Equilibrium

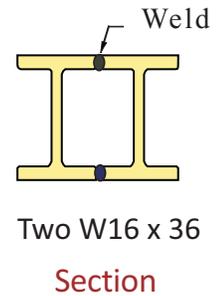
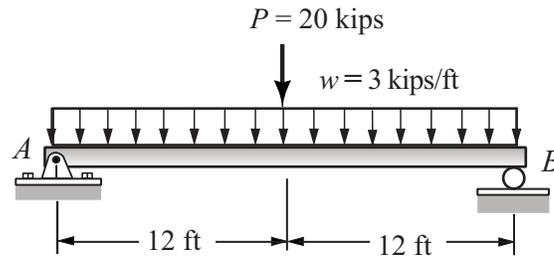
$$\begin{aligned} \Sigma F_x &= 0.00 \\ \Sigma F_y &= 0.00 \\ \Sigma M &= 0.00 \end{aligned}$$



FUNDAMENTALS OF ENGINEERING

STEEL STRUCTURES

Problem:



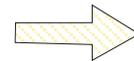
$$E = 29 \times 10^6 \text{ psi}$$

A simple 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 question:

The max. deflection (in.) of the beam is most nearly (δ_{\max})

- (A) 0.54
- (B) 1.65
- (C) 1.47
- (D) 1.25

$$\delta_{\max} = ?$$

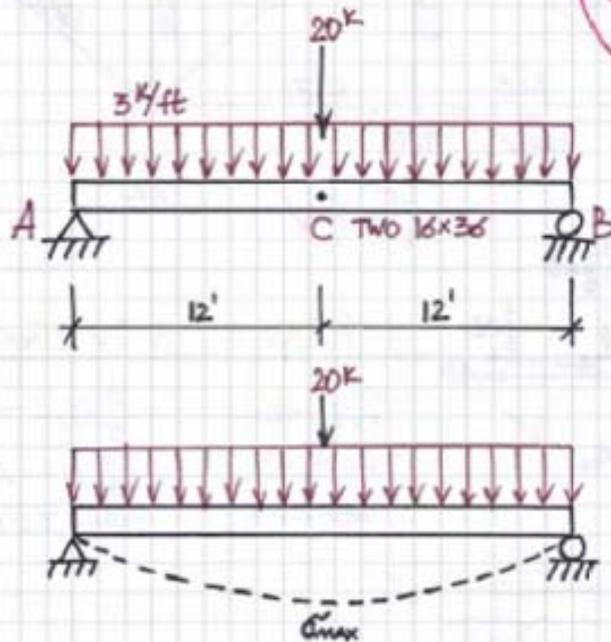


COMPLETE
SOLUTION

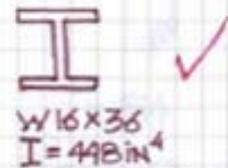
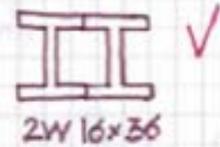


MIDTERM EXAM

PROBLEM - 1.



100/100 AZ!
 A+



$$\delta_{MAX} = \frac{5}{384} \frac{WL^4}{EI} + \frac{1}{48} \frac{PL^3}{EI}$$

$$\delta_{MAX} = \frac{5}{384} \frac{(3)(24)^4(12)^3}{(29,000)(498 \times 2)} + \frac{1}{48} \frac{(20)(24)^3(12)^3}{(29,000)(496)}$$

$$= 0.862 + 0.383 = 1.245 \text{ in.}$$

$$\delta_{MAX} = 1.245 \text{ in.}$$

EKATERINA,
 THIS WORK WAS
 TRULY
 OUTSTANDING!

EXCELLENT

Solution by Dr. Vagelis Plevris



EngiLab Beam.2D 2015 Lite - Analysis results

Node Displacements | Element End Forces | Support Reactions | Full Report (RTF) | Analysis Validation

Node ID	X-Displacement	Y-Displacement	Z-Rotation
1	0.0000	0.0000	-0.0136
2	0.0000	-0.1037	0.0000
3	0.0000	0.0000	0.0136

Cell color: Free, Constrained, Spring
Positive: Global axes
Reset
?
OK

Decimal places: 4 Displacement, 4 Rotation, 2 Force, 2 Moment

Maximum deflection:
0.1037 ft =
0.1027*12 in =
1.245 in

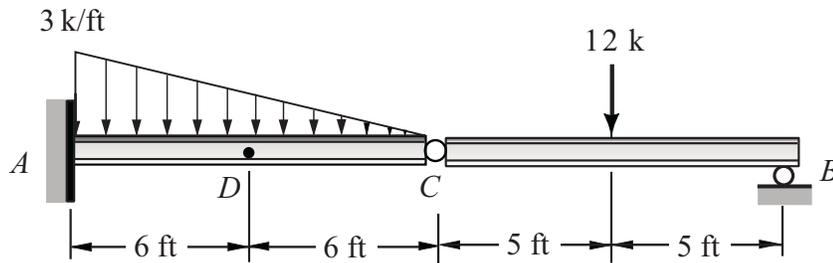
Node displacements

FUNDAMENTALS OF ENGINEERING

DETERMINATE BEAMS

Problem:

FE/PE
EXAM



Support A : Fixed
Support B : Roller

Joint C : Pin

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

(1) The support reaction (kips) at support A is most nearly (A_Y)

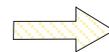
- (A) 11
- (B) 18
- (C) 22
- (D) 24

$$A_Y = ?$$

(2) The bending moment (ft-k) at A is most nearly (M_A)

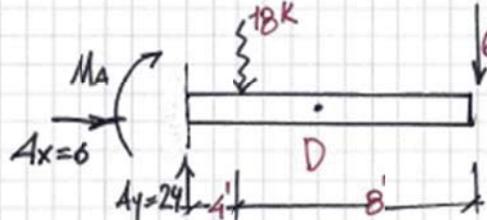
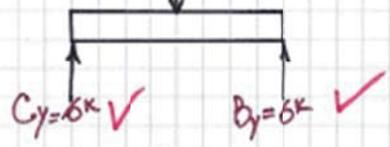
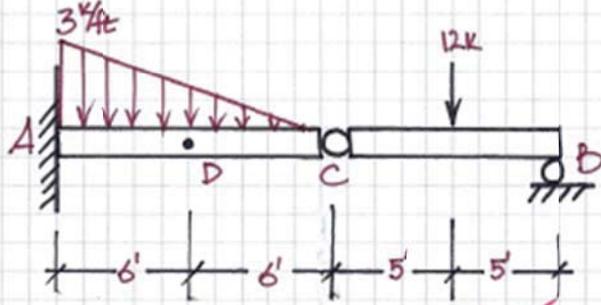
- (A) 125
- (B) 144
- (C) 160
- (D) 186

$$M_{\max} = ?$$



COMPLETE
SOLUTION

PROBLEM - 5.

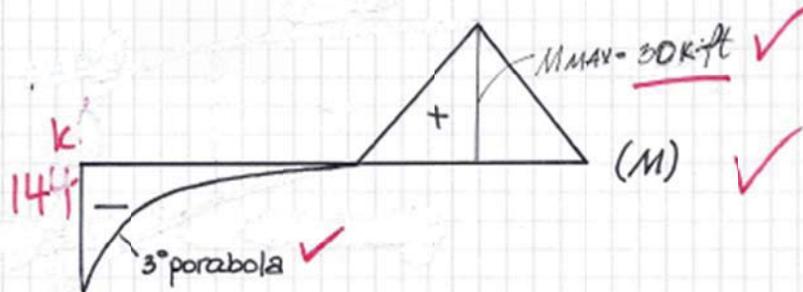
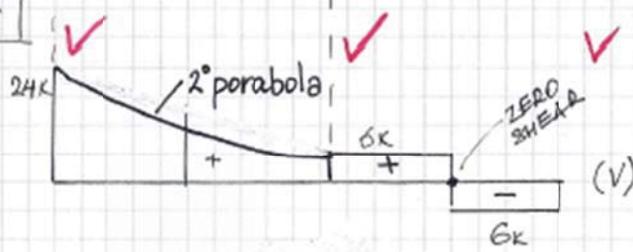


$\sum M_A = (18k)(4') + (6k)(12') = 144 \text{ k}\cdot\text{ft} \checkmark$

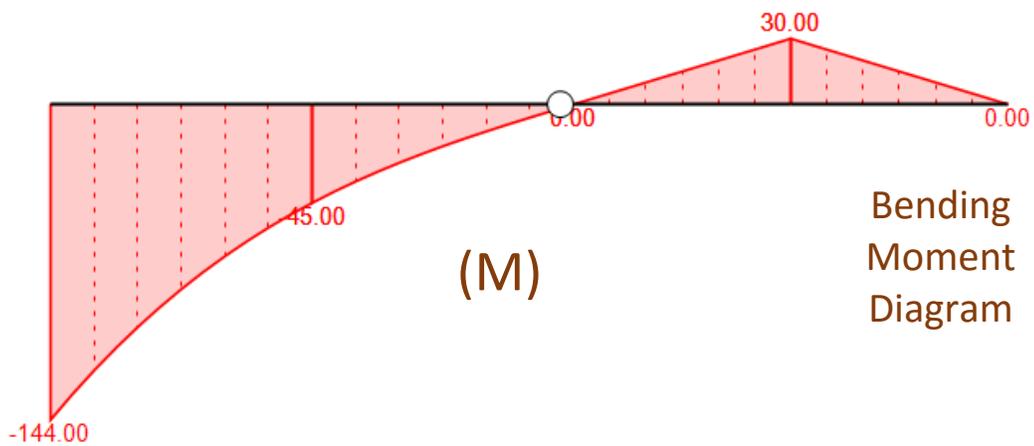
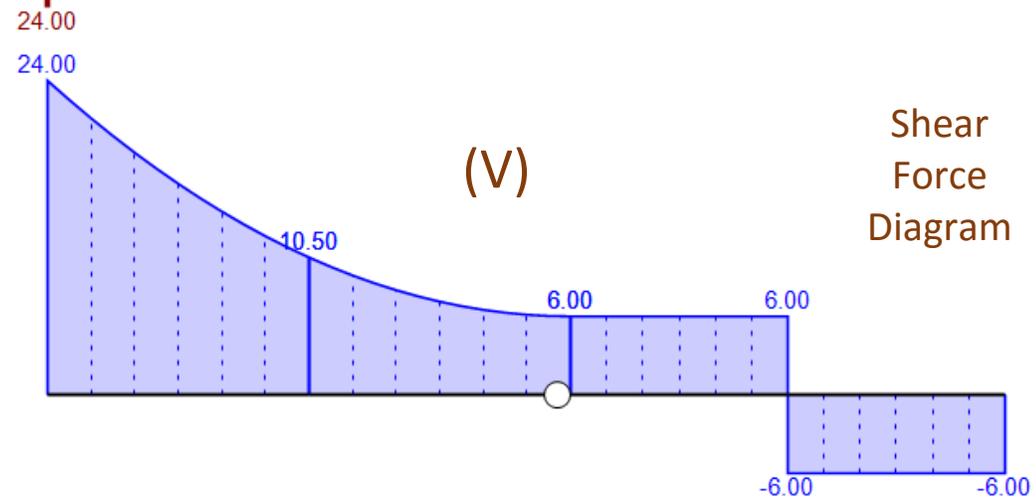
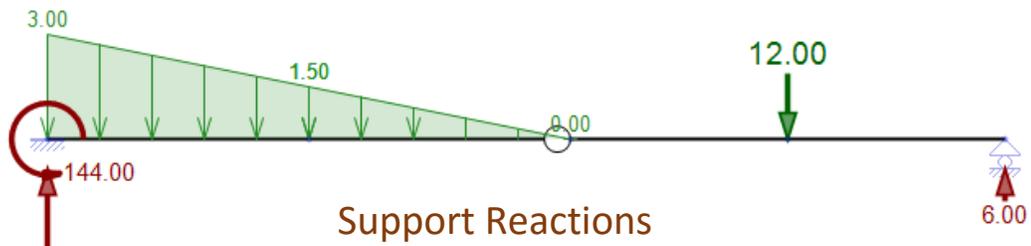
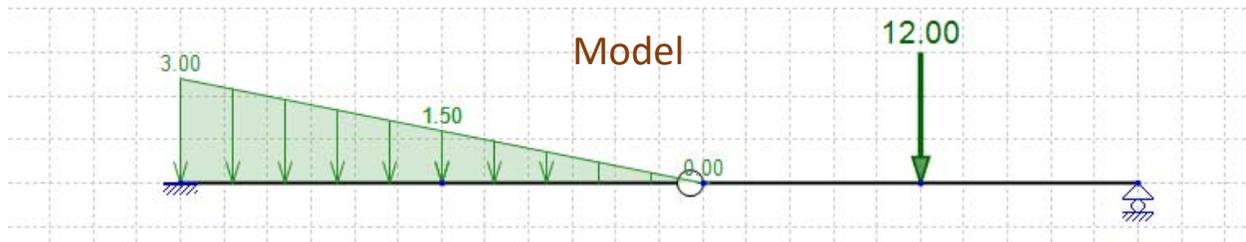
$\sum M_B = 0 \checkmark$
 $(12 \times 5) - (C_y)(10) = 0 \checkmark$
 $\sum M_D = 0 \checkmark$
 $(12)(5) + (18)(8) - 22 A_y = 0 \checkmark$
 $A_y = 24 \text{ k} \uparrow \checkmark$

EXCELLENT
Dr. Z.

SHEAR FORCE
 at D = $\frac{6 + 24}{2} = 15 \text{ k} \checkmark$



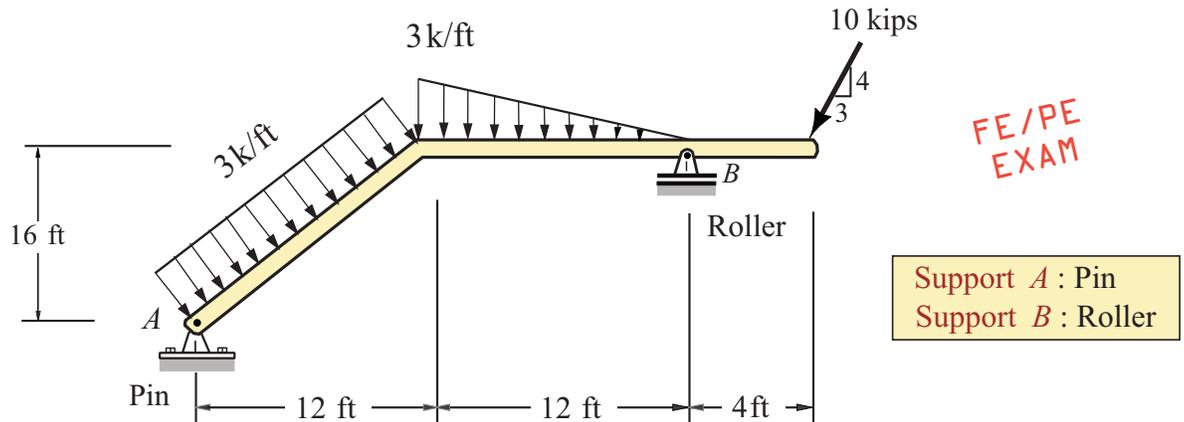
Solution by Dr. Vagelis Plevris



FUNDAMENTALS OF ENGINEERING

DETERMINATE FRAMES

Problem:



A determinate frame is loaded as shown in the figure. Using the given loads and the support conditions, answer the following questions:

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

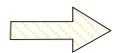
- (A) 56
- (B) 42
- (C) 32
- (D) 24

$$A_y = ?$$

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

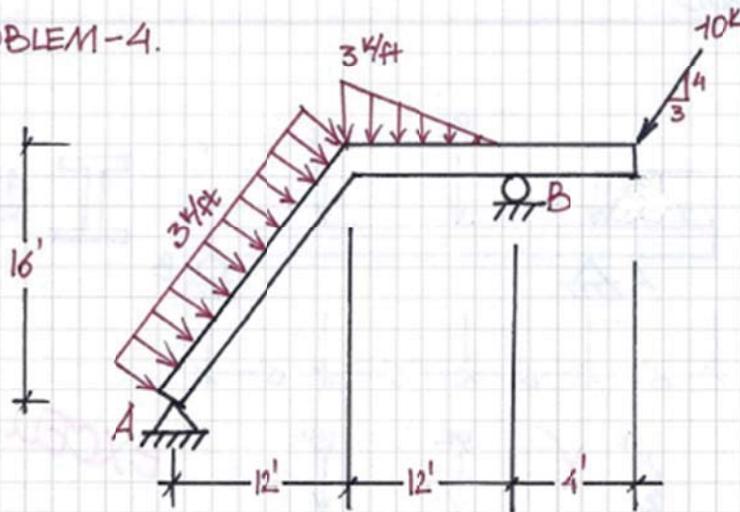
- (A) 28.65
- (B) 35.40
- (C) 42.33
- (D) 52.67

$$B_y = ?$$

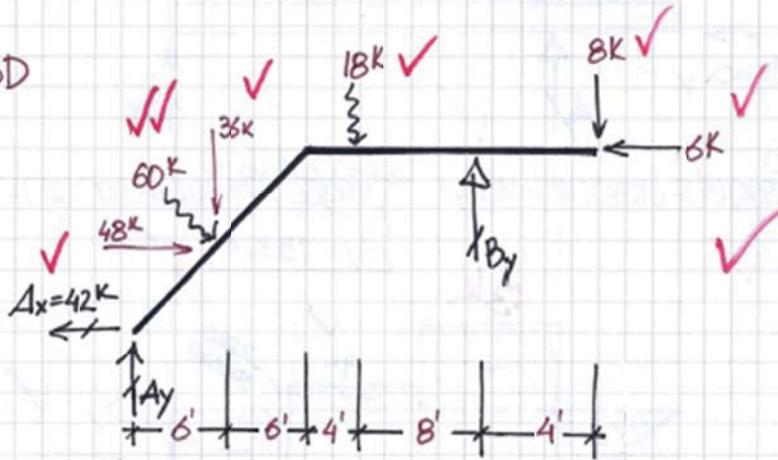


COMPLETE
SOLUTION

PROBLEM-4.



FBD



① $\rightarrow \sum F_x = 0$ ✓
 $A_x = 48k - 6k$
 $A_x = 42k \leftarrow$ ✓

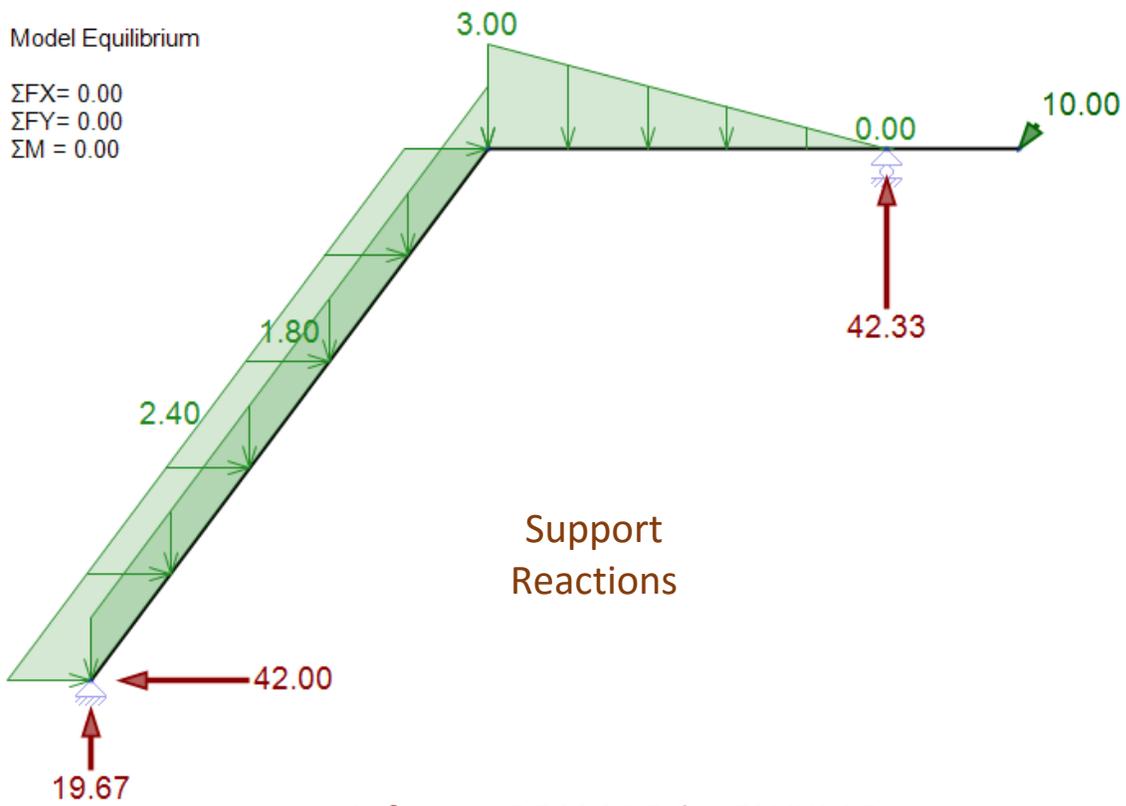
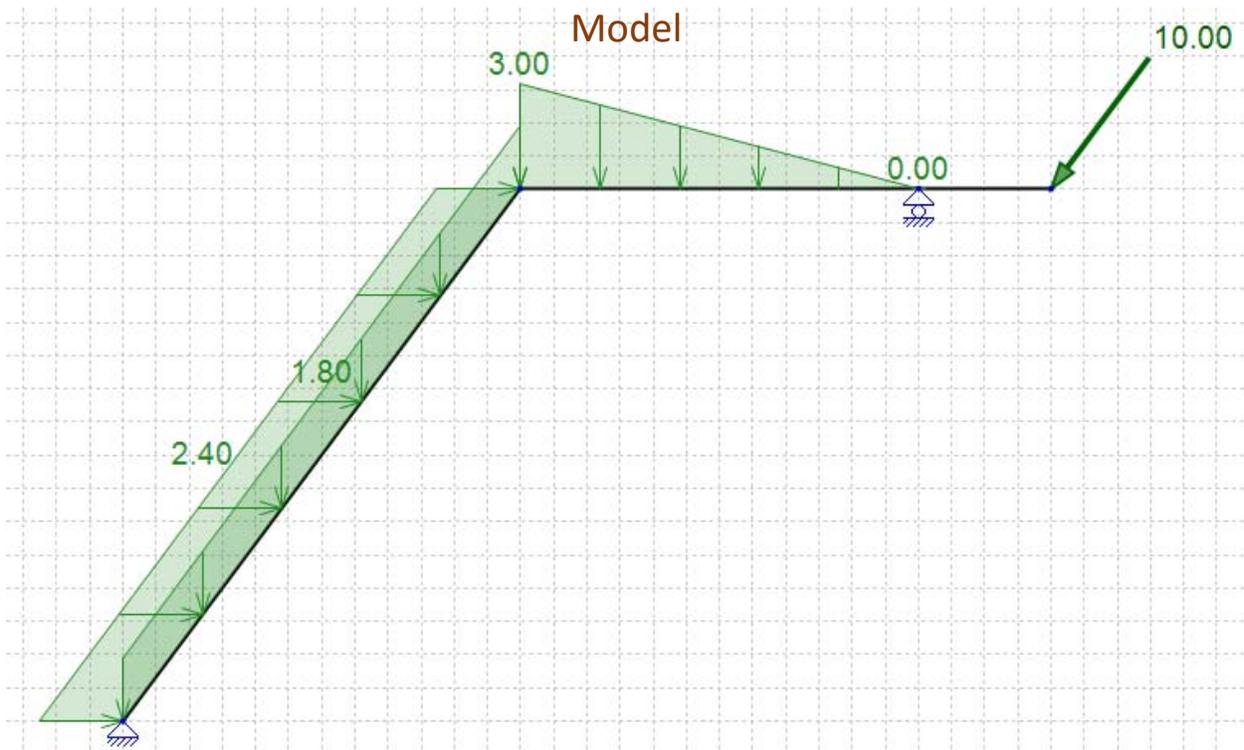
② $\uparrow \sum M_A = 0$ ✓
 $(60k)(10') + (18k)(16') + (8k)(28') - (6k)(16') = 24 B_y$
 $B_y = 42.33k \uparrow$ ✓

③ $\curvearrowright \sum M_B = 0$ ✓
 $-(8k)(4') + (18k)(8') + (36k)(18') + (48k)(8') - (42k)(16') = 24 A_y$
 $A_y = 19.67k \uparrow$ ✓

CHECK: $A_y + B_y \stackrel{?}{=} 62k$
 $42.33k + 19.67k \stackrel{?}{=} 62k$
 $62k = 62k$ OK ✓ ✓

EXCELLENT
WORK!
AZ.

Solution by Dr. Vagelis Plevris

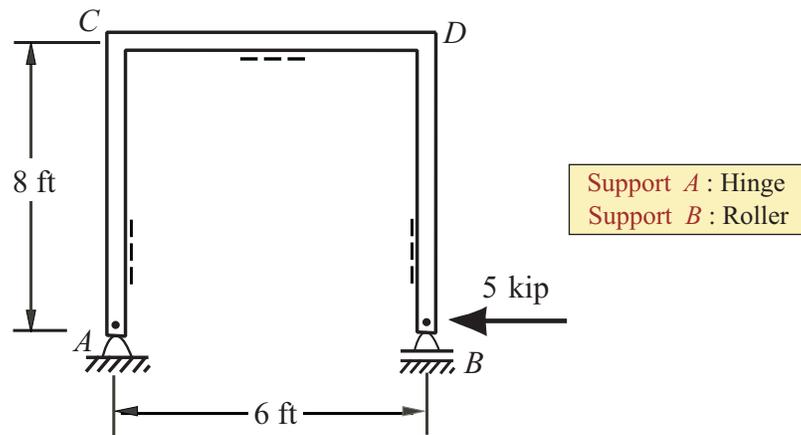


FUNDAMENTALS OF ENGINEERING

MECHANICS OF SOLIDS

Shear Force & Bending Moment Diagrams

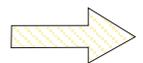
Problem: (Mechanics of Solids)



The dimensions of a determinate frame are given as shown in the figure. The support at A is a pin (hinge) and the support at B is a roller.

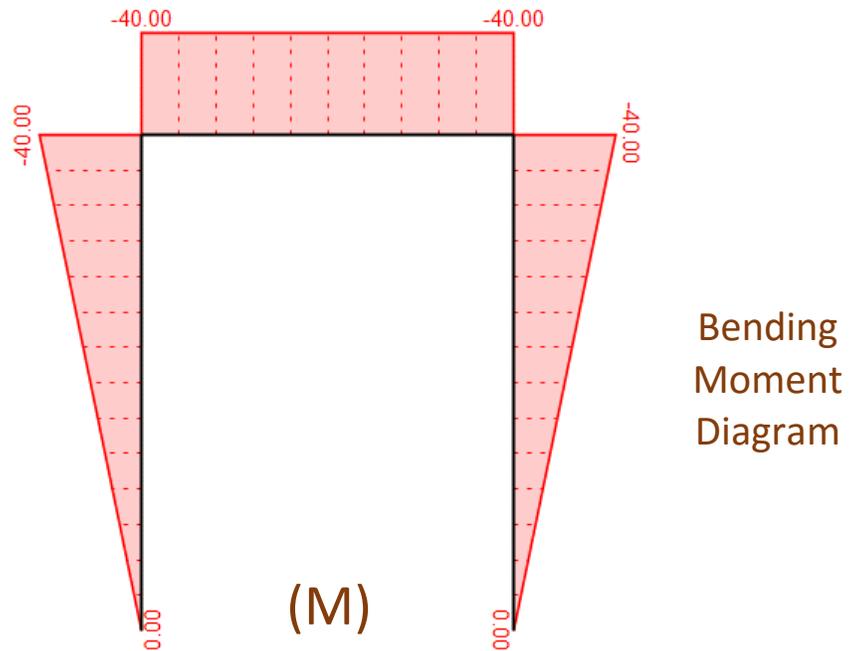
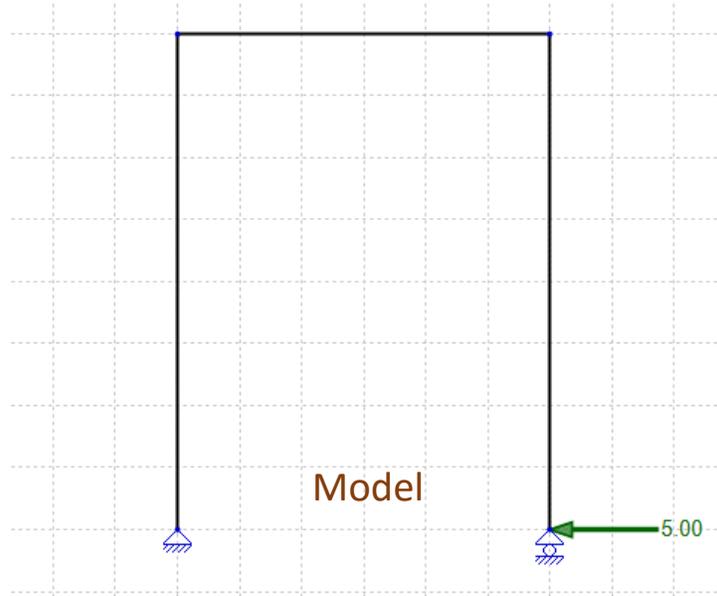
Assuming that the horizontal load $P=5k$ is applied at B as shown. The **bending moment** diagram (M) of this frame is composed of:

- (A) Three triangles
- (B) Three rectangles
- (C) One triangle and two rectangles
- (D) Two triangles and one rectangle



ANSWER

Solution by Dr. Vagelis Plevris

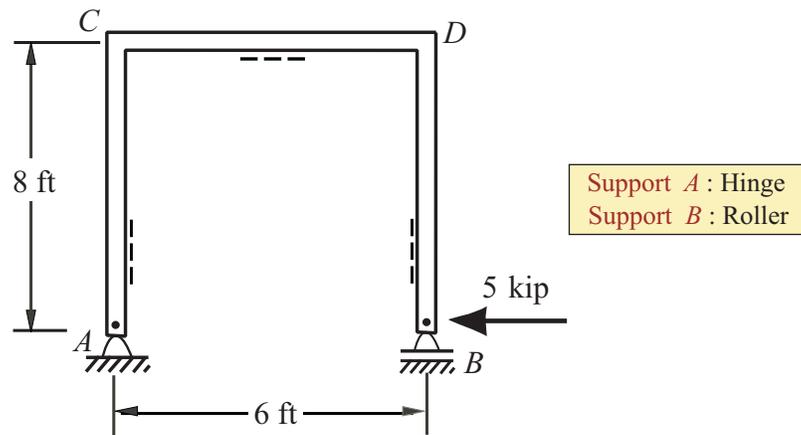


FUNDAMENTALS OF ENGINEERING

MECHANICS OF SOLIDS

Shear Force & Bending Moment Diagrams

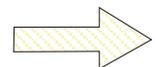
Problem: (Mechanics of Solids)



The dimensions of a determinate frame are given as shown in the figure. The support at A is a pin (hinge) and the support at B is a roller.

Assuming that the horizontal load $P=5$ kip is applied at B as shown. The **shear force** diagram (V) of this frame is composed of:

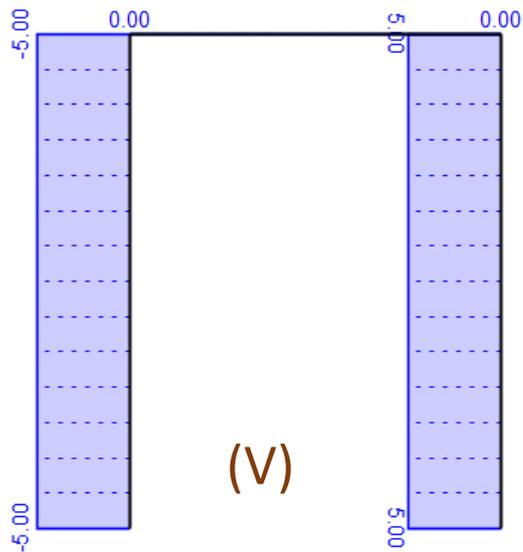
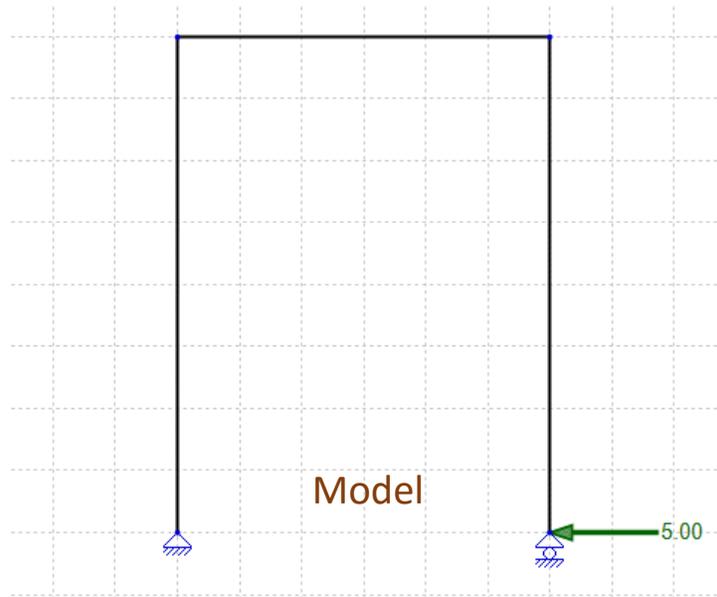
- (A) Two triangles
- (B) Two rectangles
- (C) One triangle and two rectangles
- (D) One rectangle and one triangle



ANSWER

This problem was submitted by Dr. Vagelis Plevris, P.E., Professor
School of Pedagogical & Technological Education, Athens, Greece

Solution by Dr. Vagelis Plevris



Shear
Force
Diagram



Dr. Vagelis Plevris

BSc(Eng), MSc, MBA, PhD, P.E., C.Eng, M.ASCE

Assistant Professor

Department of Civil Engineering

School of Pedagogical & Technological Education (ASPETE)

Athens, Greece

October 2, 2015

Career Highlights

1. *Neurocomputing Strategies for Solving Reliability-Robust Design Optimization Problems*
Winner of the prestigious *Emerald Literati Network Award* – 2011.
2. Developer of a Popular Finite Element Structural Analysis software package, currently being used by scores of Universities and thousands of Engineering students & practicing Engineers worldwide.
3. Editor of four Books:
 - *Seismic Assessment and Rehabilitation of Historic Structures* (IGI Global, 2015).
 - *Computational Methods in Earthquake Engineering, Vol. 2* (Springer, 2013).
 - *Design Optimization of Active and Passive Structural Control Systems* (IGI Global, 2012).
 - *Structural Seismic Design Optimization and Earthquake Engineering: Formulations and Applications* (IGI Global, 2012).
4. Active in Research; Published 14 Papers in International Refereed Journals, 32 Papers in Peer-reviewed International Conference Proceedings and 5 Book Chapters.
5. Three International Conference Proceedings volumes as Editor.
6. Reviewer of 15 International Journals.
7. Principal Investigator (PI) in two Research Grants totalling €400,000.
8. Research Associate (Co-PI) in five Research Projects with a total budget of €895,500.
9. Active Member of the Editorial Board of 2 International Journals and 3 International Conferences.
10. Co-organizer of three International Conferences.
11. 363 citations: “Google Scholar”, with Author *h*-index=9.
12. Ten years of university teaching experience, at both Bachelor’s and Master’s levels.
13. Invited Lecturer in Scientific Workshops, five lectures in several European countries.
14. Organizer of seven Special Sessions in various International Conferences.
15. Working with and mentoring for the elementary and middle school students on STEM topics in rural area public schools.
16. Amateur astronomer, avid star gazer, loves to travel and learn about different cultures & people. Fluent in four languages: English, German, Italian and Greek.

Books by V. Plevris

