

FE practice: 14 different problem types

Original questions, diagrams and complete worked solutions.

Statics / Engineering Economics / Probability / Water Treatment / Circuits / Mathematics / Ethics

This free supplement is separate from the sold 110-question Forms A and B. It contains no additional question from a paid form. Use the relevant discipline specification and the official FE Reference Handbook; the set is not a complete exam.

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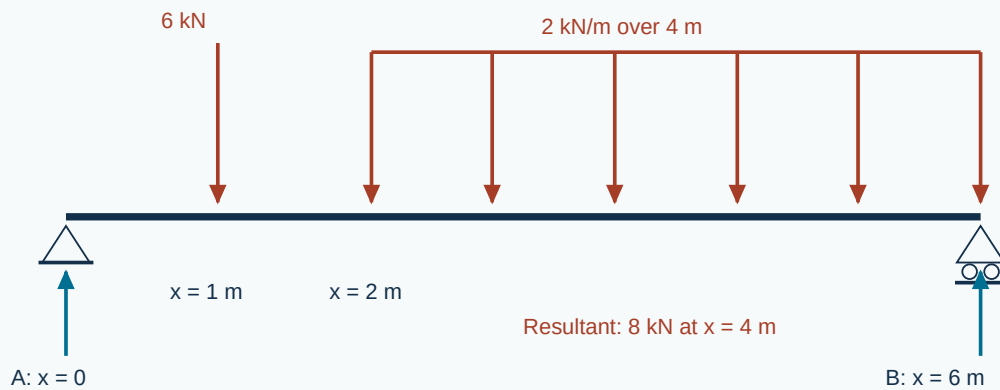
How to use this packet

Solve without reading the answer, using the current handbook and an approved calculator. Record your answer and the cause of a miss. Check the independent verification in the solution. Mark which questions you already know before interpreting any later timed result.

Support reactions with a partial distributed load

Fe Civil / Statics

Beam reactions: keep the distributed load on its actual segment



A horizontal 6 m beam is pinned at A ($x = 0$) and supported by a roller at B ($x = 6$ m). A 6 kN downward point load acts at $x = 1$ m. A uniform 2 kN/m downward load acts only from $x = 2$ m to $x = 6$ m. Neglect the beam weight. What is the upward reaction at B?

- (A) 2.00 kN
- (B) 4.00 kN
- (C) 6.33 kN
- (D) 8.33 kN

Your answer: _____ Time: _____ Handbook lookup: _____

Support reactions with a partial distributed load - worked solution

Answer (C): The reaction at B is 6.33 kN; the reaction at A is 7.67 kN.

Model

Replace the 4 m loaded segment by its 8 kN resultant at the segment midpoint $x = 4$ m, not the midpoint of the entire beam.

$$W = 2(6 - 2) = 8 \text{ kN}, x_W = 4 \text{ m}$$

Moments

Take moments about A so the reaction at A disappears. Counterclockwise moments are positive.

$$6R_B - 6(1) - 8(4) = 0, R_B = 38/6 = 6.333 \text{ kN}$$

Check

Vertical force balance gives $A = 14 - 6.333 = 7.667 \text{ kN}$. Taking moments about B independently gives $6A = 6(5) + 8(2) = 46 \text{ kN m}$.

Why the other choices fail

(A) This discards the point load and uses the wrong load lever arm.

(B) This applies the distributed resultant at $x = 3$ m and ignores the point load.

(D) This result does not satisfy the 38 kN m load moment about A.

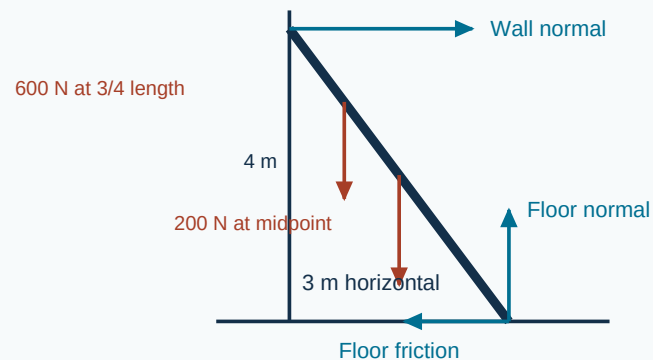
FE Reference Handbook: Statics - resultant of a distributed load and planar rigid-body equilibrium.

HTML with typeset equations: <https://engineerproof.inshihub.com/problems/statics#beam-reactions>

Impending slip: normal force versus friction

Fe Civil / Statics

Ladder: the smooth wall supplies no vertical friction force



A 5 m ladder rests against a smooth vertical wall. Its foot is 3 m from the wall and its top is 4 m high. The ladder weighs 200 N uniformly. A 600 N worker stands three-quarters of the way up the ladder. The floor alone supplies friction. What minimum coefficient of static friction at the floor prevents sliding?

- (A) 0.375
- (B) 0.500
- (C) 0.516
- (D) 0.688

Your answer: _____ Time: _____ Handbook lookup: _____

Impending slip: normal force versus friction - worked solution

Answer (C): The minimum coefficient is 0.516. The wall reaction is 412.5 N and the floor normal is 800 N.

Forces

The smooth wall has only a horizontal normal reaction. The floor normal balances both weights; the floor friction balances the wall reaction.

$$N_f = 200 + 600 = 800 \text{ N}, F_f = N_w$$

Moments

About the foot, the ladder weight has a 1.5 m horizontal arm and the worker a 2.25 m arm. The wall reaction has a 4 m vertical arm.

$$4N_w = 200(1.5) + 600(2.25), N_w = 412.5 \text{ N}$$

Limit

At impending slip, floor friction reaches its maximum. Dividing by the floor normal gives the required coefficient. A lower value cannot provide 412.5 N of friction.

$$\mu_{(s,min)} = F_f / N_f = 412.5 / 800 = 0.515625$$

Why the other choices fail

- (A) This places the worker at the ladder midpoint.
- (B) This underestimates the required horizontal reaction.
- (D) This divides friction by worker weight rather than the complete floor normal.

FE Reference Handbook: Statics - rigid-body equilibrium and limiting dry friction.

HTML with typeset equations: <https://engineerproof.inshihub.com/problems/statics#ladder-friction>

Separate an exponential model from its time constant

Fe Mechanical / Mathematics

A temperature model is $T(t)=25+50e^{(-kt)}$, with T in degrees C and t in minutes. A measurement gives $T(10) = 45$. Under this model, at what time after $t = 0$ does T reach 35 degrees C?

- (A) 6.44 min
- (B) 10.00 min
- (C) 17.56 min
- (D) 25.00 min

Your answer: _____ Time: _____ Handbook lookup: _____

Separate an exponential model from its time constant - worked solution

Answer (C): The model reaches 35 degrees C at about 17.56 minutes.

Calibrate

The excess temperature above the 25-degree surroundings falls from 50 to 20 in ten minutes. Solve for the rate parameter before extrapolating.

$$e^{(-10k)} = 20/50, k = \ln(2.5)/10 = 0.091629 \text{ min}^{-1}$$

Solve

At 35 degrees C the excess temperature is 10, so the exponential ratio is one fifth.

$$t = (\ln(50/10))/k = 17.5647 \text{ min}$$

Check

Substitute the time into the given model: $25 + 50 \exp(-k t) = 35$. The time exceeds ten minutes, as it must for a lower temperature.

Why the other choices fail

(A) This reverses the logarithm ratio.

(B) The stated ten-minute observation is 45 degrees, not 35.

(D) This assumes a linear cooling rate instead of exponential decay.

FE Reference Handbook: Mathematics - exponential functions and first-order differential equations.

HTML with typeset equations: <https://engineerproof.inshihub.com/fe-mechanical/problems/mathematics#cooling-time>

Numerical integration from measured flow

Fe Mechanical / Mathematics

A pump flow rate is measured at $t = 0$, 2 , and 4 minutes as 2 , 6 , and 4 cubic metres per minute, respectively. Using the composite trapezoidal rule with these two equal intervals, what volume is pumped from $t = 0$ to $t = 4$ minutes?

- (A) 12 m^3
- (B) 16 m^3
- (C) 18 m^3
- (D) 24 m^3

Your answer: _____ Time: _____ Handbook lookup: _____

Numerical integration from measured flow - worked solution

Answer (C): The trapezoidal estimate is 18 cubic metres.

Integrate

Integrate flow rate over time. Each two-minute interval uses the average of its endpoint rates.

$$V \approx (2)/(2)(2+6)+(2)/(2)(6+4)=8+10=18 \text{ m}^3$$

Weights

In the composite form, interior readings receive twice the endpoint weight.

$$V \approx (h)/(2)(q_0+2q_1+q_2)=(2)/(2)(2+12+4)$$

Check

The average rate over all four minutes is 4.5 cubic metres per minute. Multiplying by four independently recovers 18 cubic metres. This is a numerical estimate; it is exact only if the rate varies linearly within each interval.

Why the other choices fail

- (A) This adds the three rates without incorporating time intervals.
- (B) This uses only the two endpoints and discards the middle reading.
- (D) This applies the maximum rate for all four minutes.

FE Reference Handbook: Mathematics - numerical integration, trapezoidal rule.

HTML with typeset equations: <https://engineerproof.inshihub.com/fe-mechanical/problems/mathematics#trapezoid-volume>

When a safety judgment is overruled

Fe Mechanical / Ethics Professional Practice

An engineer identifies a credible structural hazard in equipment to be opened to the public. The employer overrules the engineer's documented recommendation to correct it. Under NCEES Model Rules 240.15 A, what is the most appropriate next action?

- (A) Accept the employer decision because the employer owns the equipment.
- (B) Notify the employer or client and an appropriate authority about the danger.
- (C) Remain silent until an accident demonstrates the hazard.
- (D) Publish confidential drawings on social media before contacting anyone.

Your answer: _____ Time: _____ Handbook lookup: _____

When a safety judgment is overruled - worked solution

Answer (B): Notify the employer or client and an appropriate authority when public safety is endangered by an overruled professional judgment.

Duty

The scenario establishes a credible public hazard and an overruled professional judgment. Section 240.15 A.1 makes public health, safety, and welfare the foremost duty.

Action

Section 240.15 A.3 requires notification to the employer or client and an appropriate authority in this circumstance. Document the engineering facts and follow applicable jurisdiction procedures.

Boundary

The model rule supplies the exam reasoning. It does not justify indiscriminate release of confidential drawings; actual legal duties depend on the jurisdiction and facts.

Why the other choices fail

(A) Ownership does not remove the public-safety duty.

(C) Waiting for harm disregards the known hazard and notification duty.

(D) Notification to an appropriate authority is not a general license to expose confidential project material.

NCEES Model Rules, August 2025: 240.15 A.1 and A.3; B.4 confidentiality.

HTML with typeset equations:

<https://engineerproof.inshihub.com/fe-mechanical/problems/ethics-professional-practice#ethics-public-danger>

Official source: https://ncees.org/wp-content/uploads/2025/09/Model_Rules_August-2025_web.pdf

A financial interest in a vendor

Fe Mechanical / Ethics Professional Practice

An engineer is evaluating two vendors for a client. The engineer owns a substantial financial interest in one vendor. Both bids meet the technical specification. Under NCEES Model Rules 240.15 B, what should the engineer do before advising the client?

- (A) Disclose the financial interest and its potential influence to the client.
- (B) Keep the interest private because both bids satisfy the specification.
- (C) Choose the other vendor so disclosure is unnecessary.
- (D) Accept an undisclosed commission if the favored vendor offers the lower price.

Your answer: _____ Time: _____ Handbook lookup: _____

A financial interest in a vendor - worked solution

Answer (A): Disclose the known or potential conflict of interest; satisfying the specification does not eliminate the appearance of influence.

Identify

The vendor ownership could influence, or appear to influence, the recommendation. The disclosure duty does not require proof that the engineer has already made a biased decision.

Apply

Section 240.15 B.6 calls for disclosure to employers or clients of interests or circumstances that may affect judgment or service quality.

Distinguish

Selecting another vendor alone does not communicate the existing interest. An undisclosed commission also introduces a separate gratuity issue under B.5. The question asks for the required first disclosure, not a blanket permission to proceed with every conflict.

Why the other choices fail

(B) Technical compliance does not remove a financial conflict.

(C) Changing the choice without disclosure conceals the known interest.

(D) Price does not justify undisclosed vendor compensation.

NCEES Model Rules, August 2025: 240.15 B.5-B.6.

HTML with typeset equations:

<https://engineerproof.inshihub.com/fe-mechanical/problems/ethics-professional-practice#ethics-vendor-interest>

Official source: https://ncees.org/wp-content/uploads/2025/09/Model_Rules_August-2025_web.pdf

Present worth with a terminal salvage value

Fe Other Disciplines / Engineering Economics

Cash-flow timing: all savings occur at the end of the year



An energy retrofit costs USD 6,500 now. It saves USD 1,800 at the end of each of the next five years and has a USD 500 salvage value at the end of year five. With an effective annual discount rate of 8%, what is its net present worth?

- (A) USD -1,473
- (B) USD 687
- (C) USD 1,027
- (D) USD 3,000

Your answer: _____ Time: _____ Handbook lookup: _____

Present worth with a terminal salvage value - worked solution

Answer (C): The net present worth is positive, about USD 1,027.

Timeline

Use end-of-year savings and discount the salvage value separately at year five. The initial cost is already at time zero.

$$PW = -6500 + 1800(P/A, 8\%, 5) + 500(P/F, 8\%, 5)$$

Evaluate

The annuity factor is 3.992710 and the single-payment factor is 0.680583.

$$PW = -6500 + 1800(1 - (1.08)^{-5}) / (0.08) + 500(1.08)^{-5} = 1027.17$$

Check

Discount each of the five USD 1,800 payments directly and add the discounted salvage. This finite cash-flow sum gives the same result. Positive present worth means the stated cash flows clear the stated 8% rate, not that omitted project risks vanish.

Why the other choices fail

- (A) This omits substantial annual benefits or misplaces their timing.
- (B) This omits the discounted USD 500 salvage.
- (D) This totals undiscounted cash flows and ignores the time value of money.

FE Reference Handbook: Engineering Economics - present worth, uniform series and single-payment factors.

HTML with typeset equations:

<https://engineerproof.inshihub.com/fe-other-disciplines/problems/engineering-economics#economic-present-worth>

Equivalent annual cost with salvage and maintenance

Fe Other Disciplines / Engineering Economics

A machine costs USD 12,000 now, lasts four years, and is sold for USD 2,000 at the end of year four. Maintenance costs USD 900 at each year end. At 6% effective annual interest, what is the equivalent annual cost?

- (A) USD 3,000
- (B) USD 3,406
- (C) USD 3,906
- (D) USD 4,500

Your answer: _____ Time: _____ Handbook lookup: _____

Equivalent annual cost with salvage and maintenance - worked solution

Answer (C): The equivalent annual cost is about USD 3,906 per year.

Annualize

Convert purchase and terminal salvage to equivalent uniform annual amounts. Maintenance is already an annual cost.

$$EAC = 12000(A/P, 6\%, 4) - 2000(A/F, 6\%, 4) + 900$$

Evaluate

Use the capital-recovery and sinking-fund factors with the same interest rate and four-year horizon.

$$EAC = 12000(0.06(1.06)^4)/((1.06)^4 - 1) - 2000(0.06)/((1.06)^4 - 1) + 900 = 3905.91$$

Check

Independently discount the four maintenance costs and salvage to time zero, add the initial purchase, and divide by the present-worth annuity factor. Both routes produce the same positive annual cost.

Why the other choices fail

(A) This divides the purchase by life and omits interest, salvage and maintenance.

(B) This straight-line calculation ignores time value of money.

(D) This omits the salvage credit and misstates the financing adjustment.

FE Reference Handbook: Engineering Economics - capital recovery, sinking fund and annual worth.

HTML with typeset equations:

<https://engineerproof.inshihub.com/fe-other-disciplines/problems/engineering-economics#economic-annual-cost>

At least two defects in a five-unit sample

Fe Other Disciplines / Probability Statistics

Each unit independently has a 0.10 probability of being defective. Five units are sampled. What is the probability that at least two are defective?

- (A) 0.01000
- (B) 0.08146
- (C) 0.32805
- (D) 0.40951

Your answer: _____ Time: _____ Handbook lookup: _____

At least two defects in a five-unit sample - worked solution

Answer (B): The probability is 0.08146, or about 8.15%.

Model

Independent identical defect events give a binomial count with $n = 5$ and $p = 0.10$.

$X \sim \text{Binomial}(5, 0.10)$

Complement

At least two is the complement of zero or one, so only two terms are needed.

$$P(X \geq 2) = 1 - (0.9)^5 - 5(0.1)(0.9)^4 = 0.08146$$

Check

Summing the four direct terms for $k = 2, 3, 4, 5$ independently gives $0.0729 + 0.0081 + 0.00045 + 0.00001 = 0.08146$. At least is not the same as exactly.

Why the other choices fail

(A) This uses the chance of two particular units being defective, ignoring other combinations.

(C) This is the probability of exactly one defective unit.

(D) This is the probability of at least one defective unit.

FE Reference Handbook: Probability and Statistics - binomial distribution and complementary events.

HTML with typeset equations: <https://engineerproof.inshihub.com/fe-other-disciplines/problems/probability-statistics#binomial-defects>

A positive inspection and the base rate

Fe Other Disciplines / Probability Statistics

Four percent of incoming parts are defective. An inspection flags 95% of defective parts and falsely flags 8% of nondefective parts. A randomly selected part is flagged. What is the probability that it is defective?

(A) 0.0400

(B) 0.3310

(C) 0.8700

(D) 0.9500

Your answer: _____ Time: _____ Handbook lookup: _____

A positive inspection and the base rate - worked solution

Answer (B): About 33.10% of flagged parts are defective under the stated model.

Partition

A flag can come from a defective part or a false positive. Weight both branches by their population fractions.

$$P(F) = 0.04(0.95) + 0.96(0.08) = 0.1148$$

Condition

Restrict the denominator to all flagged parts, not to all parts or all defective parts.

$$P(D | F) = (0.04(0.95)) / (0.1148) = 0.331010$$

Check

In a hypothetical 10,000 parts, expect 380 true flags and 768 false flags. The share $380 / (380 + 768)$ reproduces the conditional probability. Sensitivity alone does not answer the inverse question.

Why the other choices fail

(A) This is the prior defect probability before inspection.

(C) This does not use the correctly weighted false-positive branch.

(D) This is sensitivity $P(\text{flag} \mid \text{defect})$, reversing the conditioning.

FE Reference Handbook: Probability and Statistics - total probability and Bayes theorem.

HTML with typeset equations: <https://engineerproof.inshihub.com/fe-other-disciplines/problems/probability-statistics#bayes-inspection>

A steady concentration balance before treatment

Fe Environmental / Water Wastewater

Two water streams enter a perfectly mixed junction: 2 L/s at 40 mg/L and 3 L/s at 10 mg/L of a conservative dissolved substance. There is no reaction, accumulation, or loss. What is the combined outlet concentration?

- (A) 10 mg/L
- (B) 22 mg/L
- (C) 25 mg/L
- (D) 40 mg/L

Your answer: _____ Time: _____ Handbook lookup: _____

A steady concentration balance before treatment - worked solution

Answer (B): The outlet concentration is 22 mg/L, a flow-weighted average.

Balance

Conservative solute mass flow is concentration multiplied by water flow. Sum the inlet solute loads and divide by the total flow.

$$C_{\text{(out)}} = (Q_1 C_1 + Q_2 C_2) / (Q_1 + Q_2) = (2(40) + 3(10)) / (5) = 22 \text{ mg/L}$$

Check

The incoming solute load is 110 mg/s. Five litres per second at 22 mg/L carries exactly 110 mg/s; both flow and solute are conserved.

Conditions

The result lies between 10 and 40 mg/L. Reaction, evaporation or incomplete mixing would require a different model; none is present in the stated junction.

Why the other choices fail

- (A) This ignores the higher-concentration inlet.
- (C) This takes an unweighted arithmetic average despite unequal flows.
- (D) This ignores dilution from the second inlet.

FE Reference Handbook: Environmental Engineering - steady mass balance and conservative mixing.

HTML with typeset equations: <https://engineerproof.inshihub.com/fe-environmental/problems/water-wastewater#water-blend>

A plug-flow removal model and hydraulic time

Fe Environmental / Water Wastewater

A plug-flow contactor treats 0.020 cubic metres per second. A dissolved contaminant obeys first-order decay with $k = 0.15$ per minute. What minimum contactor volume achieves 90% removal under ideal plug-flow conditions?

- (A) 7.20 m³
- (B) 12.00 m³
- (C) 18.42 m³
- (D) 27.63 m³

Your answer: _____ Time: _____ Handbook lookup: _____

A plug-flow removal model and hydraulic time - worked solution

Answer (C): The required ideal plug-flow volume is about 18.42 cubic metres.

Removal

Ninety percent removal leaves an outlet-to-inlet ratio of 0.10, not 0.90. The ideal plug-flow decay law determines hydraulic residence time.

$$C_{\text{out}}/C_{\text{in}} = e^{-k\tau}, \tau = -\ln(0.10)/0.15 = 15.3506 \text{ min}$$

Units

Convert flow to 1.2 cubic metres per minute so it matches the decay constant before multiplying by time.

$$V = Q\tau = (0.020)(60)(15.3506) = 18.4207 \text{ m}^3$$

Check

The volume divided by flow gives 921.03 seconds, or 15.3506 minutes. Substitution gives $\exp(-0.15 \text{ times } 15.3506) = 0.10$. A completely mixed reactor would require a different volume formula.

Why the other choices fail

(A) This uses a different residence time without solving the logarithmic relation.

(B) This assumes ten minutes without enforcing 90% removal.

(D) This adds an unsupported safety multiplier to the ideal model.

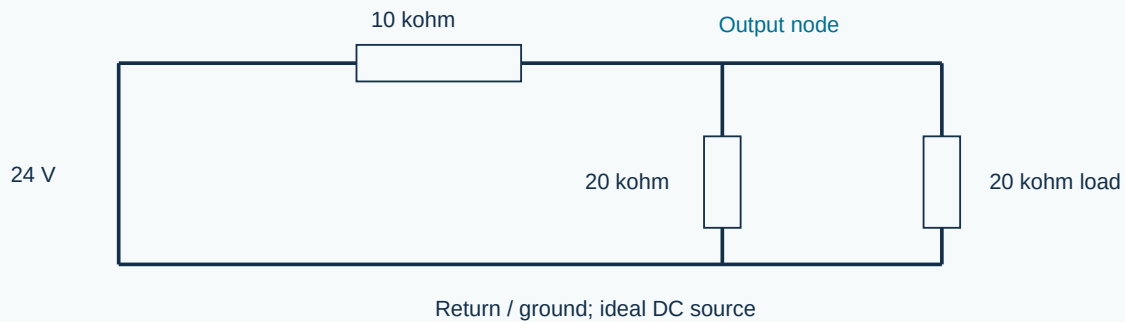
FE Reference Handbook: Environmental Engineering - first-order kinetics and ideal plug-flow residence time.

HTML with typeset equations: <https://engineerproof.inshihub.com/fe-environmental/problems/water-wastewater#first-order-treatment>

A loaded DC voltage divider

Fe Electrical Computer / Circuit Analysis

Loaded divider: the load is parallel with the lower resistor



An ideal 24 V DC source feeds a 10-kilohm series resistor. From the output node to ground are a 20-kilohm divider resistor and a 20-kilohm load in parallel. What is the steady output voltage?

- (A) 6 V
- (B) 8 V
- (C) 12 V
- (D) 16 V

Your answer: _____ Time: _____ Handbook lookup: _____

A loaded DC voltage divider - worked solution

Answer (C): The loaded output is 12 V; the load lowers it from the unloaded 16 V.

Reduce

The load is in parallel with the lower divider resistor. Two equal 20-kilohm resistors have a 10-kilohm equivalent resistance.

$$R_p = (20(20))/(20+20) = 10 \text{ kohm}$$

Divide

The source therefore sees two equal 10-kilohm resistances in series.

$$V_{\text{(out)}} = 24(10)/(10+10) = 12 \text{ V}$$

Check

The source current is 1.2 mA. At the node, each 20-kilohm branch carries 0.6 mA, which sums to the source current. The unloaded 16 V ignores the extra branch.

Why the other choices fail

(A) This uses an incorrect equivalent resistance for the two parallel branches.

(B) This gives three equal series resistors, although the lower resistors are parallel.

(D) This is the unloaded divider voltage and neglects the load.

FE Reference Handbook: Electrical and Computer Engineering - series-parallel resistance, voltage division and Kirchhoff current law.

HTML with typeset equations: <https://engineerproof.inshihub.com/fe-electrical-computer/problems/circuit-analysis#loaded-divider>

AC impedance: magnitude is not a scalar sum

Fe Electrical Computer / Circuit Analysis

An ideal 120 V rms sinusoidal source feeds a series circuit with resistance 30 ohms and net inductive reactance 40 ohms. What is the rms current magnitude?

- (A) 1.71 A
- (B) 2.40 A
- (C) 3.00 A
- (D) 4.00 A

Your answer: _____ Time: _____ Handbook lookup: _____

AC impedance: magnitude is not a scalar sum - worked solution

Answer (B): The rms current magnitude is 2.40 A. Current lags source voltage by about 53.13 degrees.

Phasor

Resistance and reactance are perpendicular components of complex impedance, not two real resistances to add.

$$Z=30+j40 \text{ ohm}, |Z|=\sqrt{30^2+40^2}=50 \text{ ohm}$$

Current

Divide the rms voltage magnitude by the impedance magnitude.

$$|I|=120/50=2.40 \text{ A}, \text{ angle } I=-\tan^{-1}(40/30)$$

Check

The resistor and reactance voltage magnitudes are 72 V and 96 V. Their vector magnitude $\sqrt{72^2 + 96^2}$ is the stated 120 V. Rms quantities stay rms throughout.

Why the other choices fail

(A) This divides by $30 + 40$ and incorrectly treats complex impedance as a scalar sum.

(C) This ignores resistance and divides only by reactance.

(D) This ignores reactance and divides only by resistance.

FE Reference Handbook: Electrical and Computer Engineering - AC phasors, impedance and Ohm law.

HTML with typeset equations: <https://engineerproof.inshihub.com/fe-electrical-computer/problems/circuit-analysis#ac-series-current>

Practice review sheet

Use a fresh input or a different problem after fixing an error. A remembered solution does not show that the setup transfers.

The editable CSV is available at: <https://engineerproof.inshihub.com/downloads/fe-practice-review-sheet.csv>

Question	Answer	Cause of miss	Next check
beam-reactions			
ladder-friction			
cooling-time			
trapezoid-volume			
ethics-public-danger			
ethics-vendor-interest			
economic-present-worth			
economic-annual-cost			
binomial-defects			
bayes-inspection			
water-blend			
first-order-treatment			
loaded-divider			
ac-series-current			