# FE Industrial and Systems

## Free practice problems and worked solutions

This sample contains 13 original problems, one from each knowledge area, already available free on EngineerProof. The original Form A problem numbers are retained. This is a sample, not a complete 110-question exam or a predictor of your NCEES result.

Work the questions before consulting the solutions. Each solution includes the calculation and an explanation of the other choices. The full forms, contents, and purchase conditions are at:

https://engineerproof.inshihub.com/fe-industrial-systems



### Included knowledge areas

# Practice questions

## Mathematics

**1.** A circular storage area has radius 7.0 m. Its floor area is most nearly:

**(A)** 154 m²

**(B)** 192 m²

**(C)** 231 m²

**(D)** 308 m²

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## Engineering Sciences

**8.** A 60 kg cart accelerates at 1.5 m/s ^ 2. Net force is most nearly:

**(A)** 22.5 N

**(B)** 45 N

**(C)** 67.5 N

**(D)** 90 N

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## Ethics and Professional Practice

**13.** A line-balancing recommendation would increase output but disables a required machine guard. The engineer should:

**(A)** Approve it for experienced operators only

**(B)** Reject the unguarded configuration and escalate a compliant alternative

**(C)** Hide the change in a trial run

**(D)** Let production targets decide

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## Engineering Economics

**17.** A project receives 25,000 USD at each year-end for four years. At 6%, present worth is most nearly:

**(A)** 21657 USD

**(B)** 43314 USD

**(C)** 64971 USD

**(D)** 86628 USD

## Probability and Statistics

**27.** From 9 distinct jobs, the number of ways to select 3 for audit is most nearly:

**(A)** 42 ways

**(B)** 84 ways

**(C)** 126 ways

**(D)** 168 ways

## Modeling and Quantitative Analysis

**38.** A linear program maximizes 5x+4y subject to x+y<=8, x<=5, y<=6, and nonnegative variables. Objective value at corner (5,3) is most nearly:

**(A)** 9.25

**(B)** 18.5

**(C)** 27.8

**(D)** 37

## Engineering Management

**48.** A project has planned value 120,000 USD and earned value 102,000 USD. Schedule performance index is most nearly:

**(A)** 0.85

**(B)** 1.06

**(C)** 1.27

**(D)** 1.7

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## Manufacturing, Service, and Other Production Systems

**56.** A line completes 420 units during 7.0 operating hours. Average throughput is most nearly:

**(A)** 60 units/h

**(B)** 75 units/h

**(C)** 90 units/h

**(D)** 120 units/h

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## Facilities and Supply Chain

**66.** A department sends 30 loads/day to a second department 20 m away. Daily load-distance contribution is most nearly:

**(A)** 150 load-m/day

**(B)** 300 load-m/day

**(C)** 450 load-m/day

**(D)** 600 load-m/day

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## Human Factors, Ergonomics, and Safety

**75.** A worker lifts a 160 N load with horizontal moment arm 0.35 m about the lower back. Load moment is most nearly:

**(A)** 14 N m

**(B)** 28 N m

**(C)** 42 N m

**(D)** 56 N m

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## Work Design

**83.** Observed cycle time is 4.8 min and performance rating is 110%. Normal time is most nearly:

**(A)** 2.64 min

**(B)** 5.28 min

**(C)** 7.92 min

**(D)** 10.6 min

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## Quality

**91.** A process mean is 50, target is 50, and specification limits are 44 and 56. With sigma=1.5, Cpk is most nearly:

**(A)** 0.667

**(B)** 1

**(C)** 1.33

**(D)** 2

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## Systems Engineering, Analysis, and Design

**102.** Three independent series components have reliabilities 0.98, 0.95, and 0.99. System reliability is most nearly:

**(A)** 0.23

**(B)** 0.461

**(C)** 0.691

**(D)** 0.922

# Worked solutions

## Mathematics

### Problem 1

**Answer: (A)**

A circular storage area has radius 7.0 m. Its floor area is most nearly:

*The circle area is 154 m².*

The requested quantity follows from the stated mathematical definition.

$$A = \pi r^2$$

Substitution and unit reduction give the reported value.

$$A = \pi(7)^2 = 154 \text{ m}^2$$

FE REFERENCE HANDBOOK — MATHEMATICS: PLANE AREAS

**WHY THE OTHER CHOICES APPEAR**

**(B)** This introduces an extra factor of 1.25 that is not present in the governing relation.

**(C)** This value is 50% above the verified result; no stated conversion creates that change.

**(D)** The units are retained, but an unsupported 2 multiplier changes the requested magnitude.

## Engineering Sciences

### Problem 8

**Answer: (D)**

A 60 kg cart accelerates at 1.5 m/s ^ 2. Net force is most nearly:

*Newton's second law gives 90 N.*

The governing engineering relation is written with consistent units.

$$F = ma$$

Substitution and unit reduction give the reported value.

$$F = 60(1.5) = 90 \text{ N}$$

FE REFERENCE HANDBOOK — DYNAMICS: NEWTON'S SECOND LAW

**WHY THE OTHER CHOICES APPEAR**

**(A)** This introduces an extra factor of 0.25 that is not present in the governing relation.

**(B)** This value is 50% below the verified result; no stated conversion creates that change.

**(C)** The units are retained, but an unsupported 0.75 multiplier changes the requested magnitude.

## Ethics and Professional Practice

### Problem 13

**Answer: (B)**

A line-balancing recommendation would increase output but disables a required machine guard. The engineer should:

*Public and worker safety takes precedence over the throughput gain.*

The guard is an explicit hazard control, so disabling it creates foreseeable exposure.

A compliant redesign can be evaluated against the same production target without accepting the hazard.

**FE REFERENCE HANDBOOK — ETHICS: SAFETY, HEALTH, AND WELFARE**

**WHY THE OTHER CHOICES APPEAR**

**(A)** Experience does not remove the known guarding hazard.

**(C)** Concealment prevents safety review and exposes workers.

**(D)** Output goals cannot override protection of worker safety.

## Engineering Economics

### Problem 17

**Answer: (D)**

A project receives 25,000 USD at each year-end for four years. At 6%, present worth is most nearly:

*The four-payment present worth is about 86,628 USD.*

The cash flows and costs are placed on the requested economic basis.

$$P = A\frac{1-(1+i)^{-n}}{i}$$

Substitution and unit reduction give the reported value.

$$P = 25000\frac{1 - 1.06^{-4}}{0.06} = 86628$$

FE REFERENCE HANDBOOK — ENGINEERING ECONOMICS: PRESENT WORTH

**WHY THE OTHER CHOICES APPEAR**

**(A)** This introduces an extra factor of 0.25 that is not present in the governing relation.

**(B)** This value is 50% below the verified result; no stated conversion creates that change.

**(C)** The units are retained, but an unsupported 0.75 multiplier changes the requested magnitude.

## Probability and Statistics

### Problem 27

**Answer: (B)**

From 9 distinct jobs, the number of ways to select 3 for audit is most nearly:

*The combination count is 84.*

The event or sampling model determines the required statistic.

$$\binom{n}{r} = n!/[r!(n-r)!]$$

Substitution and unit reduction give the reported value.

$$\binom{9}{3} = 9(8)(7)/(3(2)(1)) = 84$$

FE REFERENCE HANDBOOK — PROBABILITY: COMBINATIONS

**WHY THE OTHER CHOICES APPEAR**

**(A)** This introduces an extra factor of 0.5 that is not present in the governing relation.

**(C)** This value is 50% above the verified result; no stated conversion creates that change.

**(D)** The units are retained, but an unsupported 2 multiplier changes the requested magnitude.

## Modeling and Quantitative Analysis

### Problem 38

**Answer: (D)**

A linear program maximizes 5x+4y subject to x+y<=8, x<=5, y<=6, and nonnegative variables. Objective value at corner (5,3) is most nearly:

*Substitution at the stated feasible corner gives 37.*

The decision variables, constraints, or state model define the quantitative result.

$$Z = 5x + 4y$$

Substitution and unit reduction give the reported value.

$$Z = 5(5) + 4(3) = 37$$

**FE REFERENCE HANDBOOK — OPERATIONS RESEARCH: LINEAR PROGRAMMING**

**WHY THE OTHER CHOICES APPEAR**

**(A)** This introduces an extra factor of 0.25 that is not present in the governing relation.

**(B)** This value is 50% below the verified result; no stated conversion creates that change.

**(C)** The units are retained, but an unsupported 0.75 multiplier changes the requested magnitude.

## Engineering Management

### Problem 48

**Answer: (A)**

A project has planned value 120,000 USD and earned value 102,000 USD. Schedule performance index is most nearly:

*SPI=EV/PV=0.85.*

The project or performance metric is evaluated from its defined baseline.

$$SPI = EV/PV$$

Substitution and unit reduction give the reported value.

$$SPI = 102000/120000 = 0.85$$

**FE REFERENCE HANDBOOK — PROJECT MANAGEMENT: EARNED VALUE**

**WHY THE OTHER CHOICES APPEAR**

**(B)** This introduces an extra factor of 1.25 that is not present in the governing relation.

**(C)** This value is 50% above the verified result; no stated conversion creates that change.

**(D)** The units are retained, but an unsupported 2 multiplier changes the requested magnitude.

## Manufacturing, Service, and Other Production Systems

### Problem 56

**Answer: (A)**

A line completes 420 units during 7.0 operating hours. Average throughput is most nearly:

*Throughput is 420/7=60 units per hour.*

The process, inventory, or flow relation determines system performance.

$$R = Q/t$$

Substitution and unit reduction give the reported value.

$$R = 420/7 = 60 \text{ units/h}$$

**FE REFERENCE HANDBOOK — PRODUCTION SYSTEMS: THROUGHPUT**

**WHY THE OTHER CHOICES APPEAR**

**(B)** This introduces an extra factor of 1.25 that is not present in the governing relation.

**(C)** This value is 50% above the verified result; no stated conversion creates that change.

**(D)** The units are retained, but an unsupported 2 multiplier changes the requested magnitude.

## Facilities and Supply Chain

### Problem 66

**Answer: (D)**

A department sends 30 loads/day to a second department 20 m away. Daily load-distance contribution is most nearly:

*Flow times distance gives 600 load-m/day.*

Flow, capacity, distance, or inventory is balanced across the network.

$$LD = f_{ij} d_{ij}$$

Substitution and unit reduction give the reported value.

$$LD = 30(20) = 600$$

FE REFERENCE HANDBOOK — FACILITIES: LOAD-DISTANCE

**WHY THE OTHER CHOICES APPEAR**

**(A)** This introduces an extra factor of 0.25 that is not present in the governing relation.

**(B)** This value is 50% below the verified result; no stated conversion creates that change.

**(C)** The units are retained, but an unsupported 0.75 multiplier changes the requested magnitude.

## Human Factors, Ergonomics, and Safety

### Problem 75

**Answer: (D)**

A worker lifts a 160 N load with horizontal moment arm 0.35 m about the lower back. Load moment is most nearly:

*Force times perpendicular distance gives 56 N m.*

Exposure, force, or human-performance quantities are kept on a common basis.

$$M = Fd$$

Substitution and unit reduction give the reported value.

$$M = 160(0.35) = 56 \text{ N m}$$

FE REFERENCE HANDBOOK — ERGONOMICS: BIOMECHANICS

**WHY THE OTHER CHOICES APPEAR**

**(A)** This introduces an extra factor of 0.25 that is not present in the governing relation.

**(B)** This value is 50% below the verified result; no stated conversion creates that change.

**(C)** The units are retained, but an unsupported 0.75 multiplier changes the requested magnitude.

## Work Design

### Problem 83

**Answer: (B)**

Observed cycle time is 4.8 min and performance rating is 110%. Normal time is most nearly:

*Rating adjustment gives 5.28 min.*

Observed work is adjusted using the stated rating, allowance, or learning model.

$$NT = OT \times R$$

Substitution and unit reduction give the reported value.

$$NT = 4.8(1.10) = 5.28 \text{ min}$$

FE REFERENCE HANDBOOK — WORK MEASUREMENT: TIME STUDY

**WHY THE OTHER CHOICES APPEAR**

**(A)** This introduces an extra factor of 0.5 that is not present in the governing relation.

**(C)** This value is 50% above the verified result; no stated conversion creates that change.

**(D)** The units are retained, but an unsupported 2 multiplier changes the requested magnitude.

## Quality

### Problem 91

**Answer: (C)**

A process mean is 50, target is 50, and specification limits are 44 and 56. With sigma=1.5, Cpk is most nearly:

*Centered process capability is 1.33.*

The process statistic is compared with its control or specification basis.

$$C_{pk} = \min[(USL - \mu)/(3\sigma), (\mu - LSL)/(3\sigma)]$$

Substitution and unit reduction give the reported value.

$$C_{pk} = 6/4.5 = 1.33$$

FE REFERENCE HANDBOOK — QUALITY: PROCESS CAPABILITY

**WHY THE OTHER CHOICES APPEAR**

**(A)** This introduces an extra factor of 0.5 that is not present in the governing relation.

**(B)** This value is 25% below the verified result; no stated conversion creates that change.

**(D)** The units are retained, but an unsupported 1.5 multiplier changes the requested magnitude.

# Systems Engineering, Analysis, and Design

## Problem 102

**Answer: (D)**

Three independent series components have reliabilities 0.98, 0.95, and 0.99. System reliability is most nearly:

*Series reliability is 0.922.*

The system structure, reliability, or life-cycle relation defines the result.

$$R_s = \prod R_i$$

Substitution and unit reduction give the reported value.

$$R_s = 0.98(0.95)(0.99) = 0.922$$

**FE REFERENCE HANDBOOK — RELIABILITY: SERIES SYSTEMS**

**WHY THE OTHER CHOICES APPEAR**

**(A)** This introduces an extra factor of 0.25 that is not present in the governing relation.

**(B)** This value is 50% below the verified result; no stated conversion creates that change.

**(C)** The units are retained, but an unsupported 0.75 multiplier changes the requested magnitude.