



Newton's *Notes*

FE Mechanical Practice Problems

440 new exam-style problems in eight 55-question sets, weighted the way the NCEES FE Mechanical exam is weighted. Every answer is worked in full, with the trap behind each wrong choice.

Fadil Atcha-Dedji

Contents

	How to use this book	4
	How the sets mirror the exam	5
THE PRACTICE SETS		
1	Practice Set 1 · Exam 1, session 1	6
	Set 1 answers and solutions	13
2	Practice Set 2 · Exam 1, session 2	18
	Set 2 answers and solutions	25
3	Practice Set 3 · Exam 2, session 1	29
	Set 3 answers and solutions	36
4	Practice Set 4 · Exam 2, session 2	40
	Set 4 answers and solutions	47
5	Practice Set 5 · Exam 3, session 1	51
	Set 5 answers and solutions	58
6	Practice Set 6 · Exam 3, session 2	62
	Set 6 answers and solutions	69
7	Practice Set 7 · Exam 4, session 1	73
	Set 7 answers and solutions	80
8	Practice Set 8 · Exam 4, session 2	84
	Set 8 answers and solutions	91
BACK OF THE BOOK		
	Score tracker	95
	Topic index by exam area	96
	About the author	100

How to use this book

This book is the practice half of Newton's Notes. The companion *Review Guide* teaches the material chapter by chapter. This book mixes it up the way the exam does: one problem on beam deflection, the next on psychrometrics, the next on a conflict of interest. You have to recognize the topic yourself before you can solve it, and that skill is what the exam actually tests.

Eight sets, four full exams

The 440 problems are split into eight sets of 55. Each set carries every subject in close proportion to the NCEES exam specification, so a heavily tested subject like thermodynamics or mechanical design shows up five or six times per set, and a lightly tested one like ethics shows up twice. Sets 1 and 2 together form a complete 110-question exam with every subject inside its official range, and so do Sets 3 and 4, 5 and 6, and 7 and 8. The next pages show the exact breakdown.

How to work a set

- Give yourself 2 hours 40 minutes for 55 questions, about three minutes each, which is the pace the real exam asks of you.
- Work with only an NCEES-approved calculator and the free searchable *FE Reference Handbook* open on a screen, just as on exam day.
- Answer every question. There is no penalty for guessing.
- Mark answers on the sheet at the start of the set, then check them against the key at the end.

Reading the solutions

Each solution is tagged with its exam area and a difficulty mark: ●○○ for a one-step problem, ●●○ for a standard problem and ●●● for a multi-step problem. The sets mix all three, about one third quick, one half standard and one sixth demanding, so a set feels like the exam rather than a drill. Most wrong choices are the result of a specific, common mistake. The **TRAP** note names that mistake, so a wrong answer tells you exactly what to fix.

Track your weak spots

After each set, fill in its score-by-area table and copy the results into the score tracker at the back. Two or three sets in, your weakest areas will be obvious. Study those first, using the topic index to find every problem in this book on a given subject.

Units and conventions

Problems use SI units with $g = 9.81 \text{ m/s}^2$ and water at $1,000 \text{ kg/m}^3$ unless stated. Answers are rounded to three significant figures. If your result is close to a choice but not exact, pick the closest one, just as you would on the exam.

How the sets mirror the exam

The FE Mechanical exam has 110 questions across 14 knowledge areas. NCEES publishes a range for each area, not an exact count. Odd-numbered sets use plan A and even-numbered sets use plan B; together, one A set and one B set give the counts in the Exam column, and every count falls inside the official range.

KNOWLEDGE AREA	NCEES RANGE	SET A	SET B	EXAM	BOOK	RANGE · EXAM COUNT
1. Mathematics	6–9	3	3	6	24	
2. Probability and Statistics	4–6	2	2	4	16	
3. Ethics and Professional Practice	4–6	2	2	4	16	
4. Engineering Economics	4–6	2	2	4	16	
5. Electricity and Magnetism	5–8	3	3	6	24	
6. Statics	9–14	5	5	10	40	
7. Dynamics, Kinematics and Vibrations	10–15	6	5	11	44	
8. Mechanics of Materials	9–14	5	5	10	40	
9. Material Properties and Processing	7–11	4	4	8	32	
10. Fluid Mechanics	10–15	5	6	11	44	
11. Thermodynamics	10–15	6	5	11	44	
12. Heat Transfer	7–11	4	4	8	32	
13. Measurements, Instrumentation and Controls	5–8	3	3	6	24	
14. Mechanical Design and Analysis	10–15	5	6	11	44	
Total	110	55	55	110	440	

The shaded bar spans the NCEES range on a 0–15 scale; the solid tick marks the number of questions in each full practice exam. Source: NCEES FE Mechanical CBT exam specifications, effective July 2020. Confirm current specifications at [ncees.org](https://www.ncees.org).

What the heaviest areas mean for your study plan

Dynamics, fluid mechanics, thermodynamics and mechanical design can each supply 10 to 15 questions, and statics and mechanics of materials 9 to 14 each. Those six areas make up more than half the exam. Ethics, economics and probability are small areas, but they are also the fastest points on the exam, so they are worth securing. The topic index at the back lists every problem in this book by area and subtopic, so you can drill any one of them.

1

Practice Set 1

55 mixed questions. Allow 2 hours 40 minutes, use only your calculator and the FE Reference Handbook, and answer every question.

QUESTIONS BY AREA IN THIS SET

Mathematics	3	Probability and Statistics	2
Ethics and Professional Practice	2	Engineering Economics	2
Electricity and Magnetism	3	Statics	5
Dynamics, Kinematics and Vibrations	6	Mechanics of Materials	5
Material Properties and Processing	4	Fluid Mechanics	5
Thermodynamics	6	Heat Transfer	4
Measurements, Instrumentation and Controls	3	Mechanical Design and Analysis	5

- 1-01** A 16 mm diameter aluminum rod ($E = 70$ GPa) carries 10 kN in tension. What is the axial strain in microstrain ($\mu\epsilon$)?
 (A) $0.711 \mu\epsilon$ (B) $711 \mu\epsilon$ (C) $178 \mu\epsilon$ (D) $711,000 \mu\epsilon$
-
- 1-02** For a light, stiff tension member, which material has the highest specific stiffness E/ρ ? (Steel: $E = 200$ GPa, $\rho = 7.85$ g/cm³; Titanium: $E = 110$ GPa, $\rho = 4.5$ g/cm³; Aluminum: $E = 70$ GPa, $\rho = 2.7$ g/cm³; CFRP: $E = 150$ GPa, $\rho = 1.6$ g/cm³)
 (A) CFRP (B) Steel (C) Titanium (D) Aluminum
-
- 1-03** A thick-walled cylinder (inner radius 30 mm, outer radius 60 mm) holds 100 MPa internal pressure. What is the maximum hoop stress (at the bore)?
 (A) 100 MPa (B) 33.3 MPa (C) 66.7 MPa (D) 167 MPa
-
- 1-04** A symmetric triangular truss spans 6 m with its apex 4 m above the supports and carries 12 kN at the apex. What is the force in the bottom chord?
 (A) 12.0 kN (B) 6.00 kN (C) 7.50 kN (D) 4.50 kN
-
- 1-05** A hidden line on an orthographic drawing is drawn as:
 (A) A thin chain of long and short dashes (B) A thin continuous line with arrowheads
 (C) Short evenly spaced dashes (D) A thick continuous line
-
- 1-06** A credit line is quoted at 10% per year, compounded monthly. What annual rate is the borrower really paying?
 (A) 10.00% (B) 10.47% (C) 213.8% (D) 10.52%
-
- 1-07** Air at 120 kPa occupies 1.5 m³ and is compressed isothermally to 1/8 of its volume. How much work is done on the air?
 (A) 163 kJ (B) 158 kJ (C) 1,260 kJ (D) 374 kJ
-
- 1-08** An arithmetic progression starts at 3 with common difference 5. Which term equals 148?
 (A) 15 (B) 31 (C) 29 (D) 30
-
- 1-09** An air compressor ($\eta_c = 82\%$) takes 1.5 kg/s at 300 K through a pressure ratio of 6. What power does it need? ($c_p = 1.005$ kJ/kg·K, $k = 1.4$)
 (A) 248 kW (B) 263 kW (C) 369 kW (D) 302 kW
-
- 1-10** A temperature transmitter maps -50 to 150°C onto 0 – 10 V, read by a 12-bit ADC. What temperature change does one ADC count represent?
 (A) 0.0488°C (B) 0.0977°C (C) 0.00244°C (D) 16.7°C
-

- 1-11** A 70 kg person stands on a scale in an elevator accelerating downward at 1.5 m/s^2 . What does the scale read (in newtons)?
 (A) 105 N (B) 792 N (C) 582 N (D) 687 N
-
- 1-12** A short column of concrete ($A = 30,000 \text{ mm}^2$, $E = 30 \text{ GPa}$) and steel bars ($A = 1,200 \text{ mm}^2$, $E = 200 \text{ GPa}$) shortens together under 300 kN. How much load does the steel carry?
 (A) 63.2 kN (B) 11.5 kN (C) 237 kN (D) 150 kN
-
- 1-13** On a site visit for an unrelated project, an engineer sees a trench over 2 m deep with no shoring and workers inside. The engineer should:
 (A) Photograph it for the file and leave the site
 (B) Alert the contractor at once and report it further if it isn't fixed
 (C) Enter the trench to check the soil conditions first
 (D) Ignore it, since the trench is outside the engineer's scope
-
- 1-14** A block slides down a 40° incline. The coefficient of kinetic friction is 0.2. What is its acceleration?
 (A) 4.80 m/s^2 (B) 2.40 m/s^2 (C) 7.81 m/s^2 (D) 6.31 m/s^2
-
- 1-15** An inventor claims an engine operating between 600 K and 300 K has a thermal efficiency of 55%. This claim is:
 (A) Possible, if a better working fluid is used
 (B) Impossible, since it exceeds the Carnot limit
 (C) Possible only if the engine is reversible
 (D) Possible, since it is below the Carnot limit
-
- 1-16** An asset costs \$90,000 with a \$10,000 salvage value at the end of 8 years. What is its straight-line book value after 3 years?
 (A) \$30,000 (B) \$56,200 (C) \$50,000 (D) \$60,000
-
- 1-17** A 4 kg mass hangs from a cord wrapped around a 6 kg solid-disk pulley (radius 0.2 m) on a frictionless axle. What is the mass's acceleration?
 (A) 5.61 m/s^2 (B) 9.81 m/s^2 (C) 3.92 m/s^2 (D) 7.13 m/s^2
-
- 1-18** What is the angle between $\mathbf{A} = (2, 0, 1)$ and $\mathbf{B} = (1, 3, 0)$?
 (A) 66.4° (B) 106° (C) 73.6° (D) 16.4°
-
- 1-19** A 6 m footbridge girder rests on simple supports at A and B. A 15 kN cart stops 4 m from A. What upward force does support A provide?
 (A) 7.50 kN (B) 5.00 kN (C) 30.0 kN (D) 10.0 kN
-

Set 1 answers and solutions

Check your sheet against the key, score each area, then read the solution to every question you missed or guessed.

1	B	12	A	23	D	34	A	45	C
2	A	13	B	24	B	35	D	46	C
3	D	14	A	25	C	36	C	47	D
4	D	15	B	26	B	37	A	48	D
5	C	16	D	27	D	38	D	49	B
6	B	17	A	28	C	39	D	50	C
7	D	18	C	29	A	40	B	51	C
8	D	19	B	30	C	41	A	52	B
9	C	20	C	31	A	42	D	53	A
10	A	21	C	32	B	43	B	54	A
11	C	22	B	33	A	44	A	55	B

Score by area

AREA	QUESTIONS	YOUR SCORE
Mathematics	8, 18, 52	____ / 3
Probability and Statistics	33, 41	____ / 2
Ethics and Professional Practice	13, 29	____ / 2
Engineering Economics	6, 16	____ / 2
Electricity and Magnetism	31, 49, 51	____ / 3
Statics	4, 19, 24, 34, 38	____ / 5
Dynamics, Kinematics and Vibrations	11, 14, 17, 20, 43, 46	____ / 6
Mechanics of Materials	1, 12, 32, 35, 48	____ / 5
Material Properties and Processing	2, 25, 27, 50	____ / 4
Fluid Mechanics	26, 39, 45, 47, 54	____ / 5
Thermodynamics	7, 9, 15, 23, 37, 44	____ / 6
Heat Transfer	28, 36, 40, 55	____ / 4
Measurements, Instrumentation and Controls	10, 21, 30	____ / 3
Mechanical Design and Analysis	3, 5, 22, 42, 53	____ / 5

1-01 MECH. OF MATERIALS · ●○○

Answer (B)

$\sigma = P/A = 10,000/201.1 = 49.7 \text{ MPa}$. $\epsilon = \sigma/E = 49.7/70,000 = 7.11 \times 10^{-4} = \mathbf{711 \mu\epsilon}$.

TRAP (A) gives millistrain, not microstrain. (C) uses πd^2 as the area. (D) divides by E in GPa without converting.

1-02 MATERIALS · ●●○

Answer (A)

E/ρ : Steel 25.5, Titanium 24.4, Aluminum 25.9, CFRP 93.8.
Highest: **CFRP**.



That's the end of the sample.

You've seen the opening of Practice Set 1 and how its solutions work.
The full book holds all eight sets.

- **440 problems** in eight mixed 55-question sets
- **Four full 110-question exams**, each subject inside its NCEES range
- **Every answer worked in full**, with the trap behind each wrong choice
- **Answer sheets, score-by-area tables**, a score tracker and a topic index

The full book is coming soon in paperback and as a PDF. Watch the
Newton's Notes website for the release.