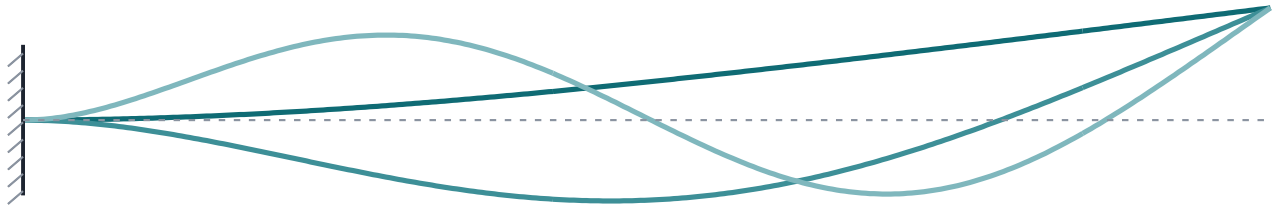
MECH3200 · ADVANCED DYNAMICS & VIBRATIONS

Worked Exam-Style Problems

20 original problems in the shape of the final exam, each solved step by step the way you would write it in the exam room, with every number checked in Python.



Built for: the current course (lists it as Engineering Dynamics 2 from 2026, same code), final exam 50%, closed book, one handwritten A4 sheet

Covers: Lagrange, natural frequencies and modes, modal analysis, damping, absorbers, isolation, strings, rods, beams, approximate methods and measurement

Every numerical answer: re-solved independently in Python (NumPy, SciPy and SymPy), by a different method wherever one exists. All 20 problems match.

Written by: a UQ mechatronics engineering graduate who took MECH3200 and tutored first-year engineering at UQ

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How to use this pack

The final is worth 50% and you need at least 40% on it to pass, so the exam room decides your grade. These problems are built to make that room feel familiar.

What the exam asks you to do

Across recent years the paper has followed a steady pattern. Three of the five questions cover discrete systems (springs, masses, Lagrange, modes, damping, absorbers, isolators and measurement). The other two cover continuous systems (strings, rods, beams) and the approximate methods. Both parts mix three kinds of marks:

- **Derive and show.** "Use Lagrange's equations to show that..." then a matrix equation of motion. P1, P2, P13.
- **Calculate.** Natural frequencies, mode shapes, modal masses, a steady response amplitude, a beam frequency from a table. Most problems here.
- **Explain and pick.** Multiple-choice and short answers on why something happens: what damping does to transmissibility, which estimate is higher, where a node sits. Every problem ends with these points in a box.

How each problem is laid out

The question	Original, in exam style. Try it first with only your A4 sheet and a Casio FX82 style calculator.
Steps	The working you would write in the booklet, in the order a marker looks for it.
Answers	Final values, rounded the way you would write them. Each one was re-computed in Python by a different route (numerical eigen-solvers, numerical integration, exact closed-form beam solutions).
Where marks go	The mistakes that cost marks on that type of question, plus the short-answer points it sets up.

A study plan that works

1. **Do them in order the first time.** P4 to P8 use the same two-mass system, so each one builds on the last.
2. **Cover the steps and write your own.** Check only after you have an answer. Writing it out is what builds speed.
3. **Time yourself on the second pass.** The exam gives you 180 minutes for 100 marks, so a 20-mark question deserves about 35 minutes.
4. **Copy the formulas you reached for onto your A4 sheet.** If you looked it up twice, it belongs on the sheet.

Problem index

#	Problem	Topic	#	Problem	Topic
P1	Skid on two springs	Lagrange, bounce and pitch	P11	Pump absorber design	Tuned absorber
P2	Coupled pendulums	Lagrange, linearising, beats	P12	Compressor mounts	Isolation, transmissibility
P3	Three masses in a row	3DOF frequencies, modes	P13	Geared drive	Torsion, gear referral, rigid-body mode
P4	Two-mass chain	Modes, orthogonality, modal mass	P14	Sensing wire	String frequencies, tension
P5	Pull and release	Free response by modes	P15	Aluminium bar	Axial and torsional rods
P6	Shaken top mass	Forced response, modal vs direct	P16	Steel flat bar	Beam frequencies, boundary conditions
P7	Choosing Rayleigh damping	α, β and modal damping	P17	Pinned beam, off-centre load	Forced beam by mode summation
P8	Near resonance	Modal damping ratios, response	P18	Bracket with an instrument	Rayleigh vs Dunkerley vs exact
P9	Reading eigenvalues	Damped eigenvalues, structural damping	P19	Three-disc shaft	Holzer's method
P10	Damper on the bottom mass	Direct complex solution	P20	A modal test	Signal processing, half-power

Units: rad/s for ω, Hz for $f = \omega/2\pi$. Gravity $g = 9.81\ \mathrm{m/s^2}$ where needed.