Cardiac phase and pressure feedback in a pulsatile circulation — review sheet

Use this after attempting the worked examples and practice. Explain each claim in words before calculating.

Key ideas

- Choose the model boundary first: six compartments conserve total blood; the two-compartment reservoir model does not have that invariant.
- Update C P when compliance varies. Backward Euler plus valve consistency is the hydraulic method.
- Euler filter, gain sign, bounded rate and accumulated shared phase must be stated separately.
- Changing resistance must change both hydraulic conductances and reported flows.
- Fixed rate permits changing stroke volume; determine rather than prescribe the sign of output change.
- Conservation, convergence, cross-language agreement and physiological validation answer different questions.

Common errors and repairs

Call the entire circulation model forward Euler. Only filter and clock are explicit Euler here; pressures come from an implicit valve-consistent solve.

Change Rs while retaining conductance matrices and flow caches. Build and report using current conductance; test the state and flow equation separately.

Drive just one ventricle with the new clock. Evaluate both compliances using the same accumulated phase.

Expect proportional feedback to reach exactly the pressure target. A persistent error can be needed to sustain a rate different from the reference.

Treat a smooth, conserved curve as sufficient numerical validation. Check valve conditions, balances, limiting cases and observable-specific refinement.

Retrieve without your notes

- What changes pressure during an isolated ventricular contraction?
- What unit conversion belongs in the phase step when time is displayed in seconds?
- What exact zero-gain limit should the code recover?
- Why is an exponential filter not an exact coupled circulation solver?

Readiness check

- Derive a six-compartment pressure update that conserves total blood volume with changing ventricular compliance.
- Distinguish the implicit hydraulic solve from the explicit filter and clock updates.
- Implement and check one Euler feedback-and-clock step, then use its common phase for both ventricular compliances.
- Diagnose a stale-conductance error and interpret a resistance perturbation without prescribing the sign of cardiac output.
- Specify independent checks and a refinement experiment before trusting a feedback response.