Final project (12 hours)

Computational Tools for Macroeconomics (MATLAB)

For January 2026 exam only

Who: students who did not submit weekly homework (type 3 students)
When: By 12:00 on 09/01/2026 here
Time budget: about **12 hours total**
Instruction: complete **as much as you can** of the three subprojects below (they increase in difficulty).
Submission: upload **one .zip** with your code + figures. Then come to the **oral exam** on the 12/01/2026 to discuss your work. **Remember to book your exam on infostud in advance**. **No submission by the deadline no exam!**

What to submit (mandatory)

- Your MATLAB code (`.m` files). Organise it as you prefer, but it must run without manual edits.
- A short `README` explaining how to run your code and what files/figures it produces.
- A `Figures/` folder with exported figures (`.png`) and (optionally) tables (as `.png` or `.pdf`).

Reproducibility: set random seeds using `rng(...)` whenever you simulate random numbers.

Subproject 1 (about 3 hours) — Linear system + correlated shocks

Goal: solve and simulate a simple linear macro model with correlated shocks using matrix algebra and Cholesky.

Model (given)

Let $y_t = \begin{bmatrix} x_t \\ \pi_t \end{bmatrix}$ and assume the equilibrium each period satisfies:

$$A y_t = b + \varepsilon_t, \quad A = \begin{bmatrix} 1 & -0.4 \\ -0.2 & 1 \end{bmatrix}, \quad b = \begin{bmatrix} 0 \\ 0 \end{bmatrix}.$$

Shocks are jointly normal:

$$\varepsilon_t \sim \mathcal{N}(0, \Sigma), \quad \Sigma = \begin{bmatrix} 1.0 & 0.6 \\ 0.6 & 1.5 \end{bmatrix}.$$

Tasks

- Simulate $T = 200$ periods of shocks ε_t using Cholesky: $\varepsilon_t = Lu_t$, where $LL' = \Sigma$ and $u_t \sim \mathcal{N}(0, I)$.
- For each t, solve $y_t = A\backslash(b + \varepsilon_t)$.
- Produce: (i) time series plot of x_t and π_t, (ii) scatter plot of x_t vs π_t, (iii) mean/std/corr of (x_t, π_t).

Subproject 2 (about 4 hours) — Deterministic consumption–saving (VFI)

Goal: solve a deterministic infinite-horizon saving problem using Value Function Iteration (VFI).

Model (given)

State: assets a. Choice: next assets a'. Budget constraint:

$$c = y + (1 + r)a - a', \quad a' \geq a_{\min}, \quad c > 0.$$

Utility (choose one):

- Log: $u(c) = \log(c)$, or
- CRRA: $u(c) = \frac{c^{1-\sigma}-1}{1-\sigma}$ with $\sigma \neq 1$.

Parameters (use these):

$$\beta = 0.96, \quad r = 0.02, \quad y = 1, \quad a_{\min} = 0.$$

Grid: $a \in [0, 20]$ with $N = 400$ grid points.

Tasks

- Implement VFI for $V(a) = \max_{a' \geq a_{\min}}\{u(c) + \beta V(a')\}$.
- Construct a feasibility/utility matrix and set infeasible choices to $-\infty$.
- Converge to tolerance 10^{-6} (or tighter) and extract the policy $a'(a)$ and consumption $c(a)$.
- Simulate a deterministic path of length 60 starting from $a_0 = 0$ using interpolation on your policy.

Outputs

- Policy plot $a'(a)$ with 45-degree line.
- Consumption plot $c(a)$.
- Simulated asset path a_t.

Subproject 3 (about 5 hours) — Unemployment risk + unemployment insurance (VFI + simulation)

Goal: extend Subproject 2 to a stochastic setting with employment risk, then compare outcomes under different unemployment insurance (UI).

Income risk (given)

Employment state $s_t \in \{E, U\}$ with transition matrix:

$$P = \begin{pmatrix} 0.95 & 0.05 \\ 0.50 & 0.50 \end{pmatrix}.$$

Income:

$$y(E) = 1, \quad y(U) = \phi,$$

where the UI replacement rate is:

$$\phi \in \{0.2,\ 0.5,\ 0.8\}.$$

Keep $\beta = 0.96, r = 0.02, a_{\min} = 0$ and the same asset grid as Subproject 2.

Tasks

For each ϕ:

- Solve the stochastic DP:

$$V(a, s) = \max_{a' \geq a_{\min}} \{u(c) + \beta \mathbb{E}[V(a', s') \mid s]\},$$

  where the expectation uses the transition matrix P.
- Plot the savings policy $a'(a, s)$ for $s = E$ and $s = U$ on the same figure.
- Simulate a stationary economy:
  - $N = 5000$ households, $T = 400$ periods, burn-in $= 100$,
  - simulate s_t using P, update assets using your policy, compute consumption from the budget constraint.
- Compute and report (per ϕ):
  - mean assets $E[a]$,
  - fraction at the constraint $Pr(a = a_{\min})$,
  - consumption volatility (choose one clearly): e.g. $\text{std}(\log c)$ or $\text{std}(\Delta \log c)$.

Outputs

- A policy figure comparing employed vs unemployed.
- A comparison plot (or table) across $\phi \in \{0.2, 0.5, 0.8\}$.

Oral exam: you should be ready to explain everything in the code you submitted. Examples:

- How you set up grids, feasibility, and the Bellman maximisation.
- How you simulated the Markov chain (Subproject 3).
- Convergence criteria and debugging checks (e.g., positive consumption, sensible policy shape).
- Economic interpretation (especially how higher ϕ affects saving and consumption volatility).