Macroeconomics 2026
Shanghai Jiao Tong University
Summer School 2026
Midterm Examination
With Solutions

Reading time: 10 minutes. **Writing time:** 120 minutes.

Total marks: 100. **Calculators are permitted.**

Instructions: Answer **all** questions. In Section A, circle the letter of the single best answer. In Sections B and C, show your working and write in clear sentences.

Structure:

- **Section A** — Multiple choice: 20 questions, 2.5 marks each (**50 marks**).
- **Section B** — One analytical problem in five parts (**30 marks**).
- **Section C** — One short interpretation (**20 marks**).

Useful formulas. Rule of 70: doubling time $\approx 70/g$; growth rates: products add, ratios subtract, powers multiply; production $Y = \bar{A}K^{1/3}L^{2/3}$, per person $y = \bar{A}k^{1/3}$; Solow $\Delta K_{t+1} = \bar{s}Y_t - \bar{d}K_t$, $k^* = (\bar{s}\bar{A}/\bar{d})^{3/2}$, $y^* = \bar{A}^{3/2}(\bar{s}/\bar{d})^{1/2}$, $K^*/Y^* = \bar{s}/\bar{d}$; growth accounting $g_{Y/L} = \frac{1}{3}g_{K/L} + g_{TFP}$; Romer $g_y = \bar{z}\,\bar{\ell}\,\bar{L}$; Jones $g_y = \lambda\bar{n}/(1-\phi)$; bathtub $u^* = \bar{s}/(\bar{s}+\bar{f})$ (here $\bar{s}$ = separation rate, $\bar{f}$ = job-finding rate), spell $= 1/\bar{f}$; Okun: each point of u above the natural rate u^* goes with output about 2% below potential; quantity theory $M_tV_t = P_tY_t$, $\pi = g_M + g_V - g_Y$; Fisher $i = r + \pi^e$; budget (simplified) $G = T + \Delta B + \Delta M$.

Section A: Multiple Choice (20 questions × 2.5 marks = 50 marks)

1. Which of the following adds to this year's GDP?

(A) A car retailer sells a vehicle that was produced two years ago.

(B) The government pays unemployment benefit to a worker.

(C) A household buys newly issued shares in a technology fund.

(D) A firm produces goods this year that remain unsold in its warehouse.

Solution. (D). GDP counts *production*, so newly produced goods enter this year even if unsold (they count as inventory investment). The old car (A) was counted when produced; the benefit payment (B) is a transfer that buys no new output; the share purchase (C) is a swap of financial assets, saving rather than production.

2. An economy produces the same quantities in two consecutive years, but every price rises by 5%. Real GDP growth between the two years is:

(A) 0%.

(B) 5%.

(C) -5%.

(D) 2.5%.

Solution. (A). Real GDP values output at fixed prices, so it moves only when quantities move; here they did not. Nominal GDP rose 5%, and the entire rise is inflation. Splitting nominal changes into a quantity part and a price part is precisely what the real/nominal distinction is for.

3. A country grows at 3.5% per year. By the Rule of 70, its income doubles roughly every:

(A) 35 years.

(B) 70 years.

(C) 20 years.

(D) 10 years.

Solution. (C). Doubling time $\approx 70/g = 70/3.5 = 20$ years. Over a 40-year working life that is two doublings, a factor of four; small differences in growth rates compound into very different lives, which is why growth dominates the first half of this course.

4. A country's price level is half the United States level. Converting its GDP to dollars at the market exchange rate, rather than at common (PPP) prices:

(A) overstates its real output by half.

(B) leaves its real output correctly measured.

(C) understates its real output by about half.

(D) doubles its measured population.

Solution. (C). Market-rate conversion values the country's output at its own low prices: the same haircut or meal counts for half. Valuing at common prices (PPP) doubles the measured output back to what is actually produced. Cheap non-traded services are why exchange-rate comparisons make poorer countries look poorer than their production really is.

5. Total GDP equals GDP per person multiplied by population. If total GDP grows at 5% and population at 2%, GDP per person grows at about:

(A) 7%.

(B) 3%.

(C) 2.5%.

(D) 10%.

Solution. (B). Growth rates of a product add, so for the ratio they subtract: $g_{Y/L} = g_Y - g_L = 5 - 2 = 3\%$. Living standards track the per-person figure; a country can post impressive total growth simply by having more people.

6. With the production function $Y = \bar{A}K^{1/3}L^{2/3}$, doubling *both* capital and labour:

(A) more than doubles output.

(B) exactly doubles output.

(C) less than doubles output.

(D) leaves output unchanged.

Solution. (B). The exponents sum to one, so scaling both inputs by 2 scales output by $2^{1/3+2/3} = 2$: constant returns to scale, the replication idea. Doubling only *one* input, by contrast, runs into diminishing returns; the two statements describe different experiments and are both true.

7. Development accounting attributes the large income gaps between rich and poor countries mostly to:

(A) the stock of capital per person.

(B) endowments of natural resources.

(C) total factor productivity.

(D) the size of the population.

Solution. (C). Because capital enters as a cube root, even big capital gaps predict modest income gaps: capital explains about a third of the differences. The remaining two-thirds is TFP, how productively inputs are used, resting on technology, institutions and human capital. Rich countries are rich mainly in productivity, not merely in machines.

8. A Solow economy has $\bar{s} = 0.2$, $\bar{A} = 1$, $\bar{d} = 0.05$. Its steady-state capital and income per person are:

(A) $k^* = 4$, $y^* = 1.6$.

(B) $k^* = 2$, $y^* = 1.3$.

(C) $k^* = 16$, $y^* = 4$.

(D) $k^* = 8$, $y^* = 2$.

Solution. (D). $k^* = (\bar{s}\bar{A}/\bar{d})^{3/2} = (0.2/0.05)^{3/2} = 4^{3/2} = 8$, and $y^* = \bar{A}\,(k^*)^{1/3} = 8^{1/3} = 2$ (equivalently $y^* = \bar{A}^{3/2}(\bar{s}/\bar{d})^{1/2} = \sqrt{4} = 2$). At $k^* = 8$: investment $0.2 \times 2 = 0.4$ equals depreciation $0.05 \times 8 = 0.4$, confirming the steady state.

9. In the Solow model *without* technological progress, the long-run growth rate of income per person is:

(A) positive but small.

(B) equal to the saving rate.

(C) negative.

(D) exactly zero.

Solution. (D). At the steady state, investment merely replaces depreciation and income per person stops growing entirely: zero, not slow. Since rich economies have in fact grown about 2% a year for over a century, machines alone cannot be the engine; that is the model's honest failure, and ideas are the repair.

10. In the Solow steady state, the capital-output ratio K^*/Y^* equals:

(A) $\bar{s}/\bar{d}$.

(B) $\bar{d}/\bar{s}$.

(C) $\bar{A}^{3/2}$.

(D) one-third.

Solution. (A). In the steady state $\bar{s}Y^* = \bar{d}K^*$, so $K^*/Y^* = \bar{s}/\bar{d}$. A country that saves more, or whose capital wears out more slowly, operates with more capital per unit of output; the prediction can be checked directly against cross-country data.

11. In Romer's model, doubling the *number of researchers* permanently doubles the growth rate. The evidence is against this, because:

(A) research employment has been falling steadily for decades.

(B) growth rates doubled even though research employment stayed flat.

(C) ideas cannot be shared across national borders at all.

(D) research effort rose many times over while growth stayed near 2%.

Solution. (D). The scale effect fails in the data: the research workforce is many times its 1950s size, yet frontier growth has hovered near 2%. Ideas have been getting harder to find; keeping Moore's Law alive now takes roughly eighteen times the researchers it took in 1971. The repaired (semi-endogenous) version ties long-run growth to population *growth*, not population *size*.

12. In the semi-endogenous (Jones) model, $g_y = \lambda\bar{n}/(1-\phi)$, a permanent government subsidy that raises the *share* of workers in research:

(A) raises the level of income but not the long-run growth rate.

(B) raises the long-run growth rate of income permanently.

(C) lowers the level of income along the entire future path.

(D) has no effect of any kind on either level or growth.

Solution. (A). The research share $\bar{\ell}$ does not appear in $g_y = \lambda\bar{n}/(1-\phi)$: shifting more workers into research raises the *path* of income (a level effect, like a higher saving rate in Solow) but the long-run growth rate is pinned by population growth and the idea-production parameters. It is a worthwhile policy (A, not D), just not a growth-rate policy.

13. The bathtub model with separation rate $\bar{s} = 2\%$ and job-finding rate $\bar{f} = 23\%$ per month gives a natural rate of unemployment of:

(A) 2%.

(B) 23%.

(C) 8%.

(D) 11.5%.

Solution. (C). $u^* = \dfrac{\bar{s}}{\bar{s}+\bar{f}} = \dfrac{2}{2+23} = \dfrac{2}{25} = 8\%$. The natural rate depends only on the two flows, in on the tap and out through the drain; the average spell here is $1/0.23 \approx 4.3$ months.

14. A student who is not working and not looking for work is counted as:

(A) unemployed.

(B) out of the labour force.

(C) employed.

(D) a discouraged worker in the unemployment rate.

Solution. (B). Being unemployed requires three things: no work, availability for work, and *active search*. A non-searcher is outside the labour force, and therefore outside both the numerator and the denominator of the unemployment rate. This is why the rate must be read alongside participation and the employment-population ratio, whose denominators do not shrink when people stop looking.

15. Long-lasting unemployment caused by the rules of the labour market itself, such as high firing costs and long, generous benefits, is called:

(A) structural unemployment.

(B) frictional unemployment.

(C) cyclical unemployment.

(D) voluntary leisure.

Solution. (A). Structural unemployment is built into the market's institutions; it persists in good times and bad. Frictional unemployment (B) is the short, healthy spell of matching between jobs; cyclical (C) rises and falls with recessions. The natural rate is frictional plus structural, and the Europe-America gap since 1980 is mostly a structural story.

16. The quantity equation $M_t V_t = P_t Y_t$ becomes a *theory* of the price level once we add the assumptions that:

(A) money and prices are both set by parliament.

(B) velocity is stable and real output is set by the real side.

(C) velocity rises mechanically whenever inflation rises.

(D) real output is strictly proportional to the money supply.

Solution. (B). As written, the equation is bookkeeping: it defines velocity. It gains content when velocity is treated as stable and real output as determined by capital, labour and ideas; then $P_t = M_t \bar{V}/Y_t$, and the price level follows money. Every quantity-theory prediction in the lecture flows from those two assumptions.

17. Money grows at 12% and real output at 2%, with stable velocity. Long-run inflation is:

(A) 14%.

(B) 12%.

(C) 6%.

(D) 10%.

Solution. (D). $\pi = g_M - g_Y = 12 - 2 = 10\%$. Ten points of money growth beyond the economy's real needs land in prices. Option (A) adds when it should subtract; option (B) forgets that a growing real economy absorbs some money growth without inflation.

18. In the government budget identity $G = T + \Delta B + \Delta M$, a government resorts to the ΔM term, printing money, when:

(A) its central bank targets low inflation.

(B) its tax revenues are running unusually strong.

(C) it can neither raise taxes nor borrow more.

(D) its outstanding debt has just been fully repaid.

Solution. (C). Spending must be financed by taxes, borrowing, or the press. When the tax system fails and lenders refuse, one term is left: ΔM. That is the fiscal root of every great inflation, and why such inflations end abruptly the day the budget is credibly fixed. The revenue it raises is the inflation tax, paid by holders of money.

19. Beyond some point, printing money even faster *reduces* the government's real revenue from the inflation tax, because:

(A) the central bank physically runs out of paper and ink.

(B) people flee from cash, shrinking the base the tax is levied on.

(C) prices eventually stop responding to the money supply.

(D) commercial banks refuse to accept new deposits.

Solution. (B). The inflation tax is levied on real money holdings, and at high inflation people hold as little cash as possible, spending it the hour it arrives. The base shrinks faster than the rate rises: a hump-shaped revenue curve. Hyperinflations sit past the peak, collecting modest revenue at catastrophic cost.

20. The United States inflation of the 1970s, unlike the classic hyperinflations, is best described as:

(A) a policy mistake, ended by determined monetary tightening.

(B) a fiscal collapse financed by the printing press.

(C) a delayed consequence of leaving the gold standard.

(D) a statistical illusion in the price indexes.

Solution. (A). The Great Inflation was not Hungary: seignorage was a trivial share of United States spending. Oil shocks plus a central bank that let money grow too fast produced it, and Paul Volcker's tightening from late 1979 ended it, at the cost of a deep recession. The fiscal story explains the great hyperinflations; moderate inflations are usually policy errors.

Section B: Analytical Problem (30 marks)

An economy is described piece by piece. Its production function is $Y = \bar{A}K^{1/3}L^{2/3}$ with $\bar{A} = 10$, $K = 27$, $L = 8$. For the long run it behaves as a Solow economy with $\bar{s} = 0.25$, $\bar{A}_S = 1$, $\bar{d} = 0.05$ (per-person units). Its central bank lets money grow at 7% while real output grows at 2%, with stable velocity; the long-run real interest rate is 2%.

(a) **[6 marks]** Compute output Y, and the incomes paid to capital and to labour under competitive markets.

(b) **[6 marks]** A neighbouring country has *27 times* this economy's capital per worker but the same productivity. Development accounting: by what factor does capital alone predict it is richer per worker? If it is actually *6 times* richer, what is its relative TFP, and how does the income gap split between capital and productivity?

(c) **[6 marks]** In the Solow block, find the steady-state income per person y^* and the steady-state capital-output ratio.

(d) **[6 marks]** Growth accounting: capital per worker grows at 3% a year and TFP at 1%. Find the growth of output per worker, and state which component dominates in the long run and why.

(e) **[6 marks]** Find long-run inflation and the Fisher nominal interest rate. If inflation then arrives at exactly the expected rate, who gains from the loans written at that nominal rate: borrowers, lenders, or neither?

Solution. (a) $K^{1/3} = 27^{1/3} = 3$ and $L^{2/3} = 8^{2/3} = 4$, so $Y = 10 \times 3 \times 4 = \mathbf{120}$. Under competition each factor earns its share, given by the exponents: capital $\frac{1}{3}Y = \mathbf{40}$, labour $\frac{2}{3}Y = \mathbf{80}$. Payments exhaust output: $40 + 80 = 120$.

(b) With $y = \bar{A}k^{1/3}$ and equal productivity, capital alone predicts a ratio of $27^{1/3} = \mathbf{3}$. The actual gap is 6, so relative TFP must be $6/3 = \mathbf{2}$: the neighbour also uses its inputs twice as productively. The gap splits as $6 = \underbrace{3}_{\text{capital}} \times \underbrace{2}_{\text{TFP}}$. Even a twenty-seven-fold capital advantage is compressed to a factor of three by the cube root; productivity does the rest.

(c) $y^* = \bar{A}_S^{3/2}\left(\frac{\bar{s}}{\bar{d}}\right)^{1/2} = \sqrt{\frac{0.25}{0.05}} = \sqrt{5} = \mathbf{2.24}$ (and $k^* = 5^{3/2} = 11.18$). The steady-state capital-output ratio is $K^*/Y^* = \bar{s}/\bar{d} = 0.25/0.05 = \mathbf{5}$: this economy holds five units of capital per unit of annual output.

(d) $g_{Y/L} = \frac{1}{3}g_{K/L} + g_{TFP}$, so $g_{Y/L} = \frac{1}{3} \times 3\% + 1\% = \mathbf{2}\%$. In the long run the **TFP term** dominates: capital deepening is self-limiting because of diminishing returns (and in the Solow block it stops entirely at the steady state), while ideas keep arriving. Sustained growth of output per worker is, at bottom, productivity growth.

(e) $\pi = g_M - g_Y = 7 - 2 = \mathbf{5}\%$, and $i = r + \pi^e = 2 + 5 = \mathbf{7}\%$. If inflation arrives exactly as expected, **neither side gains**: the 7% nominal rate already contains the 5% compensation for inflation, so the lender earns the intended 2% real return and the borrower pays it. Redistribution requires a *surprise*; anticipated inflation is just arithmetic built into the contract.

Section C: Interpretation (20 marks)

Read the following and answer in **no more than five sentences**. Use the concepts from the course; you do not need any calculation.

A country emerges from a war with its factories damaged, its tax offices barely functioning, and lenders unwilling to buy its bonds. Yet the government faces enormous bills for reconstruction and pensions. Within two years, prices are doubling every few weeks; workers insist on being paid daily and spend their wages within hours. The government blames merchants for greed and imposes strict price controls, but shortages spread and inflation resumes the moment controls are lifted. Then, in a single season, a reform programme ends the inflation almost overnight, and prices are stable within months.

Question [20 marks]. Using the tools of Lecture 6, explain where this inflation actually came from, why blaming merchants and imposing price controls failed, and what the successful reform programme must have contained for the inflation to stop so suddenly. Answer in at most five sentences.

Solution. Model answer (monetary mechanism, fiscal cause, fiscal cure). With the tax system broken and lenders gone, the budget identity $G = T + \Delta B + \Delta M$ left the government one source of finance: printing money, and by the quantity theory that torrent of money growth, far beyond real output growth, became inflation ($\pi = g_M - g_Y$): Friedman's mechanism, driven by Sargent's fiscal motive. Merchants raising prices were the messengers, not the cause; the price level was chasing the money supply. Price controls therefore attacked a symptom: with the press still running, controls only bottled up the pressure, producing shortages and queues until it burst out again the moment they were lifted. For the inflation to stop almost overnight, the reform had to fix the *budget*: restore taxes, stop financing spending with the press (often with an independent central bank forbidden to print for the government), and thereby change what people *expected*, so that holding and pricing in the currency became safe again. That is the signature of every great inflation's ending: sudden stops when the fiscal cause is credibly removed, not gradual declines from fighting the symptoms.

Marking guide (20 marks).

- **8 marks** — traces the inflation to money printed to finance the deficit: the budget identity $G = T + \Delta B + \Delta M$ with T and ΔB unavailable, plus the quantity-theory mechanism $\pi = g_M - g_Y$.
- **6 marks** — explains why controls and blaming merchants fail: they suppress the symptom while the cause (the printing) continues; shortages, then resumption.
- **4 marks** — identifies the cure's content: a credible fiscal fix (taxes restored, printing stopped, central bank independence) that changes expectations, hence the sudden stop.

- **2 marks** — clear writing within the five-sentence limit.

Answers blaming greed, wages, or foreign speculators earn little: the question tests the monetary-mechanism, fiscal-cause account taught in the lecture.