1. Explain how the CPI and the GDP deflator price indexes are constructed. In the data, which of these yields the higher rate of inflation on average? Why does this make sense in light of the way in which they are constructed?

2. Write down the definition of the unemployment rate. What are some drawbacks to measuring the health of the labor market with the unemployment rate?

3. What have been the approximate annual growth rates of real GDP per capita, nominal GDP, population, and inflation (as measured by the GDP deflator) over the last 50 years?

4. For what fraction of GDP do consumption, investment, and government spending typically account? Rank consumption and investment volatility relative to GDP volatility.

5. Which declines more during a recession: average hours worked (the intensive margin) or employment (the extensive margin)?

6. Write down the five stylized time series growth facts and the three cross-sectional stylized facts.

7. Consider the Solow model. A firm produces output according to $Y_t = AF(K_t, Z_tN_t)$, where $Z_t = (1 + g_z)^t$, $N_t = (1 + g_n)^t$, and $F(\cdot)$ is constant returns to scale. The household consumes a fixed fraction of its income each period, equal to $(1 - s)$. It invests the other fraction of its income, $s$, in new capital, with capital accumulating according to: $K_{t+1} = I_t + (1 - \delta)K_t$.

   - Derive a capital accumulation equation relating $K_{t+1}$ to $K_t$ and exogenous variables and parameters.
   - Define $\hat{k}_t = \frac{K_t}{Z_tN_t}$. Re-write the capital accumulation equation in terms of the redefined variable.
   - Graphically characterize the behavior of the economy, and argue that there exists a steady state in which $\hat{k}_t = \frac{K_t}{Z_tN_t} = \hat{k}^*$. Graphically show what happens after a permanent surprise increase in $s$, assuming that the economy begins in a steady state. Trace out the dynamic responses (impulse responses) of capital, output, and consumption. If there is any ambiguity please state why.
   - Repeat this exercise, this time considering (separately) surprise, permanent increases in $A$, $g_n$, $g_z$, and $\delta$.
   - Suppose that this economy sits in a steady state, but that a hurricane hits and destroys half of its capital stock. Show in the main diagram what happens, and trace out the dynamic responses of capital, consumption, and output.
   - Suppose that $F(K_t, Z_tN_t) = K_t^\alpha(Z_tN_t)^{1-\alpha}$. Derive an analytic expression for $\hat{k}^*$. 
• Continue to assume the Cobb-Douglas production structure. What will be the growth rate of $K_t$ in the steady state in which $\hat{k}_t$ is constant at $\hat{k}^*$? Also derive the steady state growth rates of $Y_t$, $C_t$, $R_t$ (equal to the marginal product of capital), and $w_t$ (equal to the marginal product of labor). Comment on how well these results align with the stylized facts.

• Define the Golden Rule saving rate as the saving rate which maximizes steady state consumption per effective worker, $\hat{c}_t = \frac{C_t}{\hat{z}_t N_t}$. For the Cobb-Douglas production function, find an expression for this Golden Rule saving rate.

• Is the Golden Rule saving rate affected by the level of $A$? Put differently, would the Golden rule saving rate be any different for a very rich economy (high $A$) relative to a very poor economy (low $A$)? Explain.

8. Discuss several different things that could influence total factor productivity, $A$ in the notation of the problem above.

9. (adapted from Mankiw, *Macroeconomics*, 5th edition, problem 7.8) Consider how unemployment would affect the Solow model. Suppose that output is produced according to $Y_t = AK_t^\alpha ((1-u)N_t)^{1-\alpha}$. $0 \leq u \leq 1$ is the “unemployment rate,” or fraction of workers who are not engaged in productive activity each period. It is taken to be exogenous. Capital accumulates according to $K_{t+1} = I_t + (1-\delta)K_t$, and $I_t = sY_t$. There is no population or productivity growth. We can normalize the level of workers to $N_t = 1$.

• Combine these equations to reduce the model to the standard Solow equation, expressing $K_{t+1}$ as a function of $K_t$ and exogenous variables and parameters.

• Solve for the steady state levels of $K^*$ and $Y^*$. How does the $u$ affect the steady states?

• Suppose that a change in government policy permanent reduces $u$. In a diagram, show how this will affect the economy, both immediately and in a new steady state. Will the effect on $Y_t$ be largest immediately (in the period in which $u$ declines) or in the “long run” (once we transition to a new steady state)?

10. Suppose that a household has the following economic problem:

$$\max_{C_t, S_t} \quad U = u(C_t) + \beta u(C_{t+1})$$

s.t.

$$C_t + S_t = Y_t$$
$$C_{t+1} = Y_{t+1} + (1+r_t)S_t$$

• Explain why there can be no positive or negative saving in the second period.

• Combine the two-within period budget constraints into one, and re-write the household problem as one of choosing $C_t$ and $C_{t+1}$ at time $t$ (as opposed to choosing $C_t$ and $S_t$)

• Use calculus to find the first order condition (or Euler equation) characterizing an optimal consumption plan. Provide some intuition for this condition.

• Characterize the optimal consumption plan using an indifference-curve budget line diagram. Carefully label this diagram, being sure to note what the slopes of the indifference curve and budget lines are, as well as noting the horizontal and vertical axis intercepts of the budget line.
• Graphically show what will happen to current and future consumption when $Y_t$ increases

• Do the same for (separate) increases in $Y_{t+1}$ and $r_t$. Discuss why there is some ambiguity with regards to the effect of the real interest rate on current consumption.

• Suppose that $u(C_t) = \ln C_t$. Use this, in conjunction with the Euler equation and the budget constraint to derive the consumption function. Calculate the partial derivatives of consumption with respect to $Y_t$, $Y_{t+1}$, and $r_t$. 