Part A

1. Money demand, \( \frac{M^d}{P} = L(i) \), does not depend on output in this case. The interest rate depends only on real balances, and in the short run, the interest rate changes only if the money supply changes. Thus, a fiscal expansion has no effect on the interest rate in the short run because real balances stay constant if the price level is fixed. In an IS-LM diagram, the LM curve is flat and shifts up if \( M/P \) falls. There is no crowding out of investment in the short run because the interest rate does not rise when the deficit rises. (If you consider the AS-AD diagram, then you will see that the price level rises some in the short run, \( M/P \) falls some and the interest rate rises. This effect is always present in the short run with sticky but not fixed prices. You could answer this question with either the IS-LM approach (fixed prices) or the AS-AD approach.)

In the medium run, \( P \) rises, reducing real balances until the interest rate has risen enough for output to return to the natural level. As always, crowding out is complete in the medium run.

2. If taxes are proportional to income, the propensity to consume out of GDP becomes \( (1-t)c \) instead of \( c \). The simple multiplier under proportional taxation is

\[
\frac{1}{1-(1-t)c} 
\]

which is smaller than the multiplier for constant taxes, \( \frac{1}{1-c} \). A decrease in consumer confidence (or any other reduction in autonomous demand) leads to a smaller reduction in aggregate demand if taxes are proportional because disposable income does not fall as much under proportional taxes than under constant taxes as GDP declines. The shift in the IS curve is smaller if taxes are proportional, so the decrease in GDP is less than it would be under constant taxes. Proportional income taxation is an example of an automatic stabilizer.

3. The wage setting relation is given by

\[ W = P^e F(u, z), \]

where \( W \) is the nominal wage, \( P^e \) is the expected price level and \( F(u, z) \) is a decreasing function of the unemployment rate, \( u \), and increasing function of policy factors that affect labor market decisions, \( z \).

Workers search for jobs and decide whether to take a job on the basis of the wage offered and their reservation wage. The reservation wage is the lowest wage that they would take to stop searching for a better offer. Firms consider the expected value marginal product of labor and the tightness of the labor market (the likelihood an offer will be accepted) when choosing the wages to offer. Wages are lower when unemployment is high because the probability a worker will receive an offer is lower and the probability a worker will
accept an offer is higher. Reservation wages fall when the probability a worker will receive an offer is lower because the cost of searching is higher if search takes longer.

An increase in unemployment benefits lowers the cost of searching because it lowers the cost of remaining unemployed. If search costs fall, the reservation wage rises because workers because the opportunity cost of turning a job offer down falls. (Some answers added that an increase in benefits raises the natural rate.)

4. Okun’s law is

\[ u_t - u_{t-1} = -\beta \left( g_y - g_y^- \right). \]

The parameter \( \beta \) tells us how much the unemployment rate rises when the growth rate of real GDP falls by 1%. There are two major reasons why unemployment falls by less than 1%. One is labor hoarding by firms. Firms find rehiring workers the lay off costly and that in a recovery they may have to hire new workers rather than workers whose employment skills and conduct they know. Firms will retain workers as the value marginal product of labor falls in a recession because this is less costly than rehiring. The second reason is that labor force participation declines as unemployed workers become discouraged and leave the labor force. The unemployment rate is the ratio of unemployment to the labor force. When the denominator shrinks along with the numerator, the ratio does not fall as much.

Part B

1. a) The accelerationist Phillips curve is

\[ \pi_t = \pi_{t-1} - \alpha(u_t - u_n) \]

or

\[ \pi_t - \pi_{t-1} = -\alpha(u_t - u_n). \]

b) If the central bank tries to keep unemployment below the natural rate, \( u_n \), then the right-hand side of the Phillips curve is positive. The Phillips curve tells us that inflation is rising, \( \pi_t > \pi_{t-1} \). As long as the unemployment rate is kept at a constant level below the natural rate, the inflation rate will keep going up by the same amount each month. (The central bank does this by raising the growth rate of money every month.)

c) If half of all wage contracts are indexed to inflation, then expected inflation will become

\[ \pi_t^e = 0.5\pi_t + 0.5\pi_{t-1}. \]

Substituting these expectations into the Phillips curve,

\[ \pi_t = \pi_t^e - \alpha(u_t - u_n), \]

leads to

\[ \pi_t = 0.5\pi_t + 0.5\pi_{t-1} - \alpha(u_t - u_n) \]

\[ 0.5\pi_t = 0.5\pi_{t-1} - \alpha(u_t - u_n) \]

\[ \pi_t = \pi_{t-1} - 2\alpha(u_t - u_n) \]
The Phillips curve becomes twice as steep. This means that a given reduction in the unemployment rate below the natural rate of unemployment leads to twice as large an increase in the inflation rate than when no wages are indexed. Since half of all wage contracts are indexed to actual inflation, half of all wages and prices rise automatically to actual inflation while the other half rise with the decrease in unemployment.

2. a) The three equations are

\[ \pi_t = \pi_{t-1} - \alpha(u_t - u_n) \]

\[ u_t - u_{t-1} = -\beta(g_{yt} - g_y) \]

\[ g_{yt} = g_{mt} - \pi_t. \]

In the medium run, \( u = u_n \) and \( g_y = g_y \). The unemployment and inflation rates are constant and inflation is given by \( \pi = g_m - g_y \). The inflation rate is determined by the money supply growth rate.

b) Because output growth is less than \( g_y \), Okun's law shows that the unemployment rate is rising. The unemployment rises above the natural rate so that the Phillips curve shows that the inflation rate is falling. The AD relation shows that if the growth rate of the money supply is held constant, inflation is higher than medium-run inflation if the growth rate of output is less than the natural growth rate. That is, inflation is higher than medium-run inflation and falling (some answers used the Phillips curve and Okun's law only and some used only the AD relation).

c) As output falls, inflation is falling so the AD relation shows that output growth is rising. Remember it is lower than the natural growth rate, \( g_y \), so it is rising back towards \( g_y \). As \( g_{yt} \) rises toward \( g_y \), Okun's law shows that unemployment is still rising \( (u_t - u_{t-1} > 0) \) but at a decreasing rate. Thus, output growth is less than the natural rate but rising as the unemployment rate rises. (This was not asked: when the economy hits the trough of the recession, the unemployment rate is at its highest and output growth equals the natural rate of growth. Also not asked: inflation falls through the recession and recovery).

3. a) A rise in the price of oil increases the markup in the price setting relation. This increases the natural rate of unemployment. In the medium run, the unemployment rate equals the higher natural rate, \( u'_n \), and output is lower than it would have been without the oil price rise. (The medium-run inflation rate and output growth rate are not affected.)

b) You can use the AS-AD diagram. In the short run, the AS curve shifts leftward as the natural rate of unemployment rises and natural level of output falls. The AD curve does not shift. The price level rises and output falls in the short run because unemployment is now below the new natural level. The Phillips curve tells us that inflation rises – as inflation rises, the price level goes up. The unemployment rate rises because the growth rate of GDP falls when inflation rises.
c) You can show the adjustment to the new medium run in the AS-AD diagram where the new natural level of output is lower than the original level and the AD curve has not moved. As the price level rises, the expected price level for the next year rises. Since output is still above the new natural level of output, the price level keeps rising until the new natural level of output is reached. Output falls as the price level rises because real balances decrease as the price level rises, raising the interest rate and reducing investment demand. As output falls, unemployment rises and the interest rate rises. Inflation is above its medium-run value but decreases to the medium-run value.

You can also use the Phillips curve, Okun’s law and the AD relation to explain. Because the unemployment rate is above the new natural rate, inflation rises. As inflation rises, the AD relation tells us that output growth decreases. Okun’s law tells us that unemployment is rising because output growth has fallen below the natural rate of growth. As the economy adjusts to the new medium run, unemployment continues to rise, but the output growth rate rises back to the natural rate of growth and inflation falls back to its medium-run level determined by the money growth rate, $\pi = g_m - g_y$.

d) An increase in the money supply will slow the decrease in output and the increase in the unemployment rate. The Phillips curve tells us that this increases inflation. You can use the AS-AD diagram again. An increase in the money supply shifts the AD curve up. This leads to a higher price level and higher output than when the money supply was constant because as real balances rises, the interest rate falls stimulating investment. Output falls more slowly so that unemployment rises more slowly, but prices rises faster and by more.