MAKEUP TO MIDTERM EXAM

INSTRUCTIONS: Answer any four of the six questions below. (If you answer more than four, your best four answers will be used to determine your exam grade.) Read each question carefully to make sure you understand it. Your answers should be based on the lectures and text for this course. Explain each answer; make sure it responds directly to the question that has been asked.

Please PRINT your name in CAPITAL LETTERS on the FRONT of your bluebook. When you are done, fold this paper into your bluebook, and hand in BOTH your bluebook AND this paper.

1. Susie Student consumes two goods, A and B. Her utility function is \( U = 4A^{0.5} + 8B^{0.5} \). Her income is 360. At first, the price of A is 1 and the price of B is 1. Then, the price of B rises to 2 (both the price of A and income remain unchanged).
   
   A. Calculate the substitution effect on A and B attributable to this price change.
   B. Susie's parents know that the rise in the price of B has reduced Susie's utility. How much money should they give her in order to get her utility back to its original level (i.e., the level she enjoyed before the price of B went up)?

2. Jim divides his time between hours worked for pay, \( H \), and leisure time, \( L \). When he works, he earns a wage rate of \( W \). He consumes a single consumer good, \( C \), whose price is \( P \). He also receives an amount of income \( V \) from sources other than work (e.g., interest income, dividend income, etc.). He considers both leisure and the consumer good to be "normal" goods.
   
   A. Suppose the wage rate is now 10, and the price of consumer goods \( P \) is now 1. Suppose that \( P \) rises from 1 to 2. Other things being equal, is it possible to say how this will affect Jim's hours of work, \( H \)? Explain your answer.
   B. Suppose the wage rate is now 10, and the price of consumer goods \( P \) is now 1. Suppose that \( W \) rises from 10 to 11. Other things being equal, is it possible to say how this will affect Jim's purchases of the consumer good, \( C \)? Explain your answer.

3. The total product of labor (TPL) schedule at the XYZ Corp. is shown in the graph below. (Note that this is drawn for a fixed level of capital, \( K = 10 \).) Note that the TPL schedule increases at an increasing rate for all levels of labor below \( L_1 \); and increases at a constant rate for all levels of labor equal to or greater than \( L_1 \). Using this information, graph the company's average product of labor (APL) and marginal product of labor (MPL) schedules. (Note: produce this graph in your bluebook, not on this exam paper.)
4. A consumer purchases only two goods, F and G, out of a fixed income I. The price of F rises. Given this information, discuss each of the following statements, and explain whether it is certainly true, certainly false, or uncertain (i.e., could be either true or false):

A. "If G is a Giffen good, then consumption of G must fall in response to the rise in the price of F."
B. "If consumption of G falls in response to the rise in the price of F, then G is a Giffen good."

5. Lee divides his time between hours of work H and hours of leisure L, and is paid a wage of $10 per hour, regardless of how many or how few hours he works. He also receives $10 per week in income from sources other than work (interest earnings, stock dividends, etc.). At the moment, he works 35 hours per week.

A. Draw Lee's budget line and show the location of his indifference curve-budget line tangency.
B. Lee's employer decides to pay its employees an overtime wage. Under this new policy, work will be paid at the rate of $30 per hour for the first 35 hours per week; but hours worked in excess of 35 hours per week will be paid at the rate of $45 per hour. Is it possible to say whether, after this new policy takes effect, Lee will increase, reduce, or not change his hours of work (which are currently 35 hours per week)? Explain your answer.

6. Ximing, a student, purchases textbooks and other goods. Each semester, he purchases eight new textbooks at a cost of $50 each (for a total cost of 8 × $50 = $400). (Used textbooks cost $30 each.) Then the price of new textbooks rises by 20%, to $60 each. (Prices of all other goods, including used textbooks, remain unchanged.) Ximing asks his father to increase his allowance by $80 (= 8 × $10), enough to cover the increased cost of new textbooks. If his father agrees, will Ximing be better off, the same, or worse off? Explain your answer.
KEY TO MAKEUP TO MIDTERM EXAM

1. To answer this question, we need to know the marginal utilities of A and of B, and the "equal bang per buck" (EBPB) rule. MUA = ∂U/∂A = ∂{4A^{0.5} + 8B^{0.5}}/∂A = 2A^{-0.5} (remember that B is constant here – do you know why?). Likewise, MUB = ∂U/∂B = ∂{4A^{0.5} + 8B^{0.5}}/∂B = 4B^{-0.5}. So EBPB requires $2A^{0.5}/P_A = 4B^{0.5}/P_B$. (Note that this is always true, regardless of what the prices of A and B may be.)

For the initial equilibrium, $P_A = P_B = 1$, so here EBPB requires $2A^{0.5}/1 = 4B^{0.5}/1$, or $2A^{0.5} = 4B^{0.5}$. Divide both sides by 2, to get $A^{-0.5} = 2B^{-0.5}$. Next, square both sides, to get $A^{-1} = 4B^{-2}$. Multiply both sides by AB, to get $B = 4A$. This is one equation in our two unknowns, A and B. When we know income, the budget constraint provides the other equation in the two unknowns, $I = P_A A + P_B B$. In the initial equilibrium, we have $P_A = P_B = 1$, and $I = 360$, so we have $360 = A + B$. Now substitute $B = 4A$ into this equation, to get $360 = A + 4A$, or $5A = 360$, or $A = 72$. Since $B = 4A$, $B = 4 \times 72 = 288$. Finally, we can solve for utility with $A = 72$, $B = 288$: $U = 4A^{0.5} + 8B^{0.5} = 4(72)^{0.5} + 8(288)^{0.5} = 169.71$. So at the initial equilibrium, we have $A = 72$, $B = 288$, and $U = 169.71$.

For the new equilibrium, $P_A = 1$ and $P_B = 2$, so now EBPB requires $2A^{0.5}/1 = 4B^{0.5}/2$, or $A^{0.5} = B^{0.5}$, so now $A = B$. This is one equation in our two unknowns, A and B. When we know income, the budget constraint provides the other equation in the two unknowns, $I = P_A A + P_B B$. In this new equilibrium, we have $P_A = 1$, $P_B = 2$, and $I = 360$, so we have $360 = A + 2B$. Now substitute $B = A$ into this equation, to get $360 = A + 2A$, or $3A = 360$, or $A = 120$. Since $B = A$, $B = 120$ also. Finally, we can solve for utility with $A = 120$, $B = 120$: $U = 4A^{0.5} + 8B^{0.5} = 4(120)^{0.5} + 8(120)^{0.5} = 131.45$. So at the new equilibrium, we have $A = 120$, $B = 120$, and $U = 131.45$.

(A) To get the substitution effects on A and B attributable to the change in price, we need to determine how A and B change when prices change, but with utility held constant. Note that we could do this either at the old level of utility, or the new level of utility – your answer needed to do it only one way.

At the old level of utility, we need to consider how A and B will change when we change prices from $P_A = P_B = 1$ to $P_A = 1$, $P_B = 2$ with utility held constant at its original level, 169.71. At the new prices $P_A = 1$ and $P_B = 2$, EBPB requires $2A^{0.5}/1 = 4B^{0.5}/2$, or $A^{0.5} = B^{0.5}$, or $A = B$. (See above!) This is one equation in our two unknowns, A and B. The second equation is the utility function, since we know that utility must stay at 169.71. So we must have $U = 169.71 = 4A^{0.5} + 8B^{0.5}$. Substitute $A = B$ into this expression, to get $169.71 = 4A^{0.5} + 8A^{0.5} = 4A^{0.5} + 8A^{0.5} = 12A^{0.5}$, or 169.71/12 = $A^{0.5}$ = 14.125. Square both sides to solve for $A$: $A = 200.01$. Since $A = B$, $B = 200.01$ also. Now we can calculate substitution effects: relative to the original equilibrium, A has changed by $200.01 - 72 = +128.01$, and B has changed by $200.01 - 288 = -87.99$. So the substitution effect on A is +128.01, and the substitution effect on B is -87.99. (Thus, A rose and B fell in response to the rise in the price of B.)

At the new level of utility, we need to consider how A and B will change when we change prices from $P_A = 1$, $P_B = 2$ to $P_A = 1$, $P_B = 1$ with utility held constant at its new level, 131.45. At the old prices $P_A = P_B = 1$, EBPB requires $2A^{0.5}/1 = 4B^{0.5}/1$, or $A^{0.5} = B^{0.5}$, or $A = B$. (See above!) This is one equation in our two unknowns, A and B. The second equation is the utility function, since we know that utility must stay at 131.45. So we must have $U = 131.45 = 4A^{0.5} + 8B^{0.5}$. Substitute $A = B$ into this expression, to get $131.45 = 4A^{0.5} + 8A^{0.5} = 4A^{0.5} + 16A^{0.5} = 20A^{0.5}$, or 131.45/20 = $A^{0.5}$ = 6.57. Square both sides to solve for $A$: $A = 43.20$. Since $B = 4A$, $B = 172.79$. Now we can calculate substitution effects: relative to the new equilibrium, A has changed by $43.20 - 120 = -76.80$, and B has changed by $172.79 - 120 = 52.79$. So the substitution effect on A is -76.80, and the substitution effect on B is +52.79. (Thus, when the price of B fell from 2 to 1 at the same level of utility, A fell and B increased.)

(B) This question is asking for the compensating variation (CV) in income that will offset the effect of the rise in the price of B. To answer this question, you first need to determine how much money it will take to achieve the original level of utility (which we calculated as 169.71 – see above) at the new set of
relative prices ($P_A = 1$, $P_B = 2$). Note that in Part A we did most of the work for this, because (see above) we calculated the substitution effect at the old level of utility – in other words, we calculated the equilibrium levels of A and B at the new set of relative prices and the old level of utility! So all we have to do now is to determine how much it will cost to buy these new levels of A and B, and then determine how much more money this is than Susie's current income level (360). We calculated (see above) that $A = B = 200.01$ at the old level of $U$ and the new prices. Thus, the income necessary to buy these quantities, at the new prices, is $I = 1 \times 200.01 + 2 \times 200.01 = 600.03$. Susie's original level of income was 360. Thus, we need to give her $600.03 - 360 = 240.03$ more in income: this is the CV associated with the rise in the price of B from 1 to 2. (Note also that this is less than the "cost of living adjustment" necessary to allow her to purchase the original quantities of A and B: B rose in price by $1$, and she was buying 288 units of B. So a "cost of living adjustment" would have meant giving her 288, not 240.03.)

2. Use income and substitution effects!

(A) **Substitution effect:** The rise in P must cause consumers to substitute away from C (whose price has gone up) and towards L (whose relative price, W/P, has gone down). So L will rise via the substitution effect. **Income effect:** You know that L is a normal good. So a rise in P (the price of consumer goods), which must make Jim worse off, will reduce demand for L. Thus, the total effect is indeterminate (the substitution effect will raise L, but the income effect will reduce it). So you can't say what will happen to L on balance due to the rise in P, and therefore you also can't say what will happen to H on balance due to the rise in P (since H and L must move in opposite directions).

(B) **Substitution effect:** The rise in W must cause consumers to substitute away from L (whose price has gone up) and towards C (whose relative price, P/W, has gone down). So C will rise via the substitution effect. **Income effect:** You know that C is a normal good. So a rise in W (which must make Jim better off) will increase C. Thus, we can be sure C will rise as a result of the rise in W: both the income effect and the substitution effect act to increase C.

3. See Figure 3(A), and remember that, at any given level of Q, $APL = Q/L = \text{slope of line from the origin to the TPL schedule}$, and $MPL = \Delta Q/\Delta L = \text{slope of line tangent to the TPL schedule}$. First consider APL. Until $L = L_1$, APL is rising as $L$ rises (see graph below). Moreover, APL continues to rise even when $L$ is greater than $L_1$. So APL is rising at all levels of $L$. Next, consider MPL. As shown below, MPL rises (in other words, the slope of the tangent line is getting steeper) as $L$ rises, up to where $L = L_1$. However, once $L = L_1$, the slope of the tangent line is constant (that is, the slope of the tangent line remains the same at all levels of $L$ beyond $L_1$).

Finally, consider how APL and MPL behave in relation to each other. Below $L$, note that APL is always less than MPL (see graph below). Also, above $L$, note that APL is again always less than MPL (again, see graph below). Thus, APL is always less than MPL; APL is always rising; and MPL rises until $L = L_1$, and is constant thereafter. This is shown in the Figure 3(B).
4. Again, as in #3, use income and substitution effects!

(A) This statement is definitely false. A Giffen good is an inferior good for which the income effect is stronger than the substitution effect. (So a rise in its price will generate a positive income effect on demand for the good that will outweigh the negative substitution effect – which, in turn, will mean that consumption of the good will rise.) Substitution effect: A rise in the price of F will lead to a substitution effect that will increase G (and reduce F) – substitution is always away from the good whose price went up, and towards the good whose relative price has fallen. Income effect: The rise in the price of F will make the consumer worse off, which will increase consumption of inferior goods – including G, since G is an inferior good. But note that this means that, in response to the rise in the price of F, consumption of G must rise (since both the income and substitution effects on G are positive). So the statement is false: the rise in the price of F must raise demand for G, not reduce it.

(B) This statement is definitely false. Substitution effect: A rise in the price of F will lead to a substitution effect that will increase G (and reduce F) – substitution is always away from the good whose price went up, and towards the good whose relative price has fallen. Income effect: The rise in the price of F will make the consumer worse off, which will increase consumption of inferior goods and reduce consumption of normal goods; so, to begin with, we can't say anything about the income effect. However, note that here we are told that the total effect of the rise in the price of F is a decrease in consumption of G. Since the substitution effect of the rise in the price of F will always raise demand for G, it's not possible for the total effect of the rise in the price of F to cause a decrease in consumption of G unless the income effect reduces demand for G. But if the income effect of the rise in the price of F reduces demand for G, that must mean G is a normal good. (Remember that a price rise makes you worse off, which reduces demand for normal goods.) And if G is a normal good, then G can't possibly be a Giffen good. (As noted in Part (A), a Giffen good is an inferior good.)

5(A). See graph below. The budget line is Tvd, and equilibrium occurs at point E on indifference curve U*. Note that since Lee's equilibrium is an interior solution, his budget line and indifference curve are tangent at the equilibrium, and their slopes are therefore equal.

(B) It is not possible to say how this change in Lee's budget line will affect his labor supply. Note that his original wage is $10/hour, whereas the new budget line consists of two parts: a wage of $30/hour for hours worked up to 35 per week, with an "overtime" wage of $45/hour for hours worked in excess of 35 hours per week. The increase in his wage will entail both an income effect and a substitution effect: the higher wage will make Lee better off, and (provided leisure is a normal good) this will reduce his hours of work – this is the income effect; but the higher opportunity cost of leisure will make him increase his hours of work – this is the substitution effect. On balance, it's not possible to say how this will affect Lee's hours of work, since the income and substitution effects will pull him in opposite directions.

Likewise, it is possible that the high "overtime" wage of $45/hour might make Lee willing to work many more hours. If this has any effect at all, it will primarily have a substitution effect (since it is paid only for an increase in hours worked beyond the equilibrium level of 35 hours/week). However, if the rise in the "basic" wage to $30 reduces Lee's hours worked to something less than 35 hours/week, the "overtime" wage may not have any effect at all. More generally, the "overtime" wage will induce Lee to work more
than 35 hours/week only if he is already working at or close to this level. See the graphs below for some examples.

6. Note that this is another variant on the topic of cost-of-living adjustments. Ximing is asking for a "cost of living" adjustment that makes it possible for him to buy texts again, even though they have risen in price. In particular, note that an increase in his allowance of $80 would allow him to buy eight new textbooks at the higher price (since the price of each textbook went up by 20%, or $10). So, in terms of the graph below, increasing his allowance by $80 would allow him to remain at his original equilibrium point, E, where he purchased eight new textbooks. However, this "cost of living adjustment" is more than the "compensating variation" necessary to keep his utility unchanged despite the price increase. In fact, it is "too much" – i.e., more than the amount necessary to keep his utility constant. So, if his father agrees to this, Ximing will be better off than he was originally. In other words, as shown below, his original budget line is ab; the price rise changes his budget to ac; and budget line de gives him the compensating variation necessary to keep his utility unchanged despite the price increase is (note that de is parallel to ac and is tangent to his original indifference curve) – the amount of the extra income here is distance cd. In contrast, giving him enough money to allow him to go on buying eight textbooks, despite the price increase, would put him on budget line fg (note that fg passes through the original equilibrium point, E, but that its slope is equal to the new set of relative prices because it is parallel to ac). This would give him more money (distance cf) than is necessary to keep his utility constant.