By writing your name on this exam you certify that you have not violated the University’s Code of Academic Contact (for example, you have not copied from the work of another student and you have not knowingly facilitated cheating by another student).

If you submit the exam without writing your name and ID, you will get a score of 0 for this exam.

If you don’t explain (= show your work for) your answers you will get no credit.

If you do not stop writing when told so (at the end), a penalty of 10 points will be deducted from your score.
1. [18 points] Consider the following two lotteries: \( L = \left( \frac{\$0}{\frac{1}{3}}, \frac{\$600}{\frac{2}{3}} \right) \) and \( M = \left( \frac{\$200}{\frac{2}{3}}, \frac{\$500}{\frac{1}{3}} \right) \).

All three individuals below prefer more money to less and have transitive preferences.

(a) [6 points] Jeb says that he prefers \( L \) to \( M \). What can we say about his attitude to risk?

(b) [6 points] Ann says that she prefers \( M \) to $312 for sure. What can we say about her attitude to risk?

(e)[6 points] Bruno says that he would prefer $295 for sure to \( L \). What can we say about his attitude to risk?

2. [42 points] Consider the following diagram, where \( NI \) denotes the No-Insurance point and the two downward-sloping straight lines are isoprofit lines. The slope of each isoprofit line is \( -0.2 \).

(a) [2 points] What are the initial wealth \( W_0 \), the potential loss \( \ell \) and the probability of loss \( p \)?
(b) [2 points] Calculate the expected value of the lottery corresponding to No Insurance.

(c) [2 points] What is the expected profit from contract C? [Explain.]

(d) [4 points] Write the equation of the isoprofit line that goes through point C.

(e) [4 points] Calculate the coordinates of point C and also express contract C in terms of premium and deductible.

(f) [4 points] Calculate the premium \( h_d \) and deductible \( D_d \) of contract A.

(g) [4 points] Calculate the expected profit from contract B.

(h) [4 points] Write the equation of the isoprofit line that goes through point A.
(i) [4 points] Calculate the coordinates of point B and also express contract B in terms of premium and deductible.

(j) [4 points] Express contracts A and B as lotteries and calculate their expected value.

(k) [2 points] Explain why a risk-neutral person would be indifferent between No Insurance and contract C.

(l) [3 points] Explain why a risk-averse person would prefer contract B to contract A.

(m) [3 points] Suppose that the individual is offered only contract B and decides to buy it. What is her attitude to risk?

3. [40 points] Amy has been suffering from knee pain for a while now. The doctor suggests having an operation, which will not cost her anything since it is covered by her health plan. The only downside is that in 2% of the cases the operation fails and leads to permanent damage of the knee. Thus, as presented to her, the choice is between

- having the operation, which can be thought of as the lottery \( O = \begin{pmatrix} z_1 \\ z_3 \end{pmatrix} \), where \( z_1 \) is the outcome where the knee is completely healed and \( z_3 \) is the outcome where the knee is permanently damaged, and
not having the operation, which corresponds to the lottery \( N = (z_2 \begin{pmatrix} 2 \\ 1 \end{pmatrix}) \), where \( z_2 \) is the outcome where her knee remains in the current painful state.

**Assume throughout that Amy has von Neumann-Morgenstern preferences.** Her ranking of the outcomes is the obvious one: \( z_1 \succ z_2 \succ z_3 \).

(a) [3 points] What can you say about Amy’s normalized utility function if she decides to have the operation?

(b) [2 points] Suppose that Amy is risk averse. Will she have the operation?

Amy’s boyfriend works for an insurance company and informs her that his company offers insurance that covers unsuccessful operations. The insurance contract is as follows: the customer pays a premium of $8,000 and then, if the operation fails, the insurance company will make a payment of $25,000 to the customer (but not if the operation is successful). **Amy’s initial wealth is $12,000.** Considering this option expands the set of possible outcomes, as described below in terms of the decision made and the corresponding outcome:

(c) [5 points] Fill in each box by encoding each outcome as a pair \((x, y)\) where \( x \) is Amy’s final wealth and \( y \in \{D, H, P\} \) is the state of her knee \((H = \text{healed}, D = \text{permanently damaged}, P = \text{current state of painful knee})\).

| \( z_1 \) | No insurance, operation, success |
| \( z_2 \) | No insurance, no operation |
| \( z_3 \) | No insurance, operation, failure |
| \( z_4 \) | Insurance, operation, success |
| \( z_5 \) | Insurance, operation, failure |

Amy has three possible courses of action:
- \( O = \) do not insure and have the operation,
- \( N = \) do not insure and do not have the operation,
- \( I = \) insure and have the operation

(we ignore the obviously strictly dominated choice of insuring and not having the operation).

(d) [3 points] Represent each of the three choices as a lottery over the set \( \{z_1, z_2, z_3, z_4, z_5\} \).
Suppose that Amy’s ranking of the outcomes is as follows: \( z_1 \succ z_4 \succ z_5 \succ z_2 \succ z_3 \).

(e) [8 points] Will Amy decide to have the operation? [Note: in part (a) we did not state that Amy would choose to have the operation; we had a hypothetical question “IF she decided to have the operation …”].

(f) [8 points] Amy’s boyfriend asks her: “if you decided to have the operation, would you buy insurance?” Amy says Yes. What can you say about Amy’s normalized utility function?

(g) [8 points] Amy says that she has the following preferences:

\[
\begin{pmatrix} z_3 & z_1 \\ 0.06 & 0.94 \end{pmatrix} \sim z_5 \text{ and } \begin{pmatrix} z_5 & z_1 \\ \frac{1}{6} & \frac{5}{6} \end{pmatrix} \sim z_4 .
\]

Check whether Amy’s answer to the question in part (f) is consistent with these preferences.

(h) [3 points] What will Amy decide to do?