1. (20 min) Define and explain in a brief paragraph (about 50-60 words) the following two concepts, with an accompanying equation or diagram where appropriate, its significance in microeconomic theory:

(a) principle of complementary slackness;
(b) deadweight loss from monopoly.

2. (25 min) Consumers buy insurance from a competitive insurance industry. Each consumer is an expected utility maximizer with utility function $u(x) = \ln(x)$ for final consumption $x$. Each consumer has initial wealth $w = $20k. There are two types of consumers, high risk and low risk. High risk consumers have a probability $\frac{2}{3}$ of losing $10k$, while low risk consumers have a probability $\frac{1}{3}$ of losing $10k$.

(a) First, suppose that insurance companies can distinguish between high and low risk consumers, that they maximize expected profit, that they are risk neutral and that they earn zero expected profit: in other words that they offer actuarially fair insurance in which the premium $\pi_i$ paid per dollar insurance is equal to the probability of the loss event in segment $i$.

i. What premiums do they charge to the two types of consumers, i.e. what price do they charge per dollar insurance purchased by the consumers if the insurance companies expect to make zero net profits in expectations to each segment of consumers (and thus you need to specify two different premia.)?

ii. For a given premium $\pi$ per dollar insurance purchased (not necessarily the fair premium computed above), graphically describe the trade-off for the two kind of consumers using budget constraint and indifference curves. How does their choice differ for the same premium $\pi$.

iii. Now, formally describe the insurance problem of each consumer in terms of the insurance coverage $y$ bought as derived from the constrained optimization problem of the consumer if each consumer segment faces a zero net profit premium $(\pi_1, \pi_2)$. 


(b) Now suppose that insurance companies cannot distinguish high and low risk consumers (and maintain the assumption that they maximize expected profit, that they are risk neutral and that they earn zero expected profit.) What problem would arise if the insurance companies tried to sell insurance policies to the consumers as described in part (a)? A verbal answer is sufficient, but explain your reasoning.

3. **(30 min)** Ann has utility function

$$u_A(x_{A1}, x_{A2}) = x_{A1} + \alpha \cdot x_{A2}$$

over consumption this year ($x_{A1}$) and consumption next year ($x_{A2}$), where $\alpha \in (0, 1)$. Bob has utility function

$$u_B(x_{B1}, x_{B2}) = \ln(x_{B1}) + \ln(x_{B2})$$

over the consumption this year ($x_{B1}$) and consumption next year ($x_{B2}$). Ann has $100k$ this year, but no income next year. Bob has $50k$ this year and $200k$ next year.

(a) Describe this exchange economy in an "Edgeworth box". Carefully label all the graph and all of its components.

(b) Describe the Pareto efficient allocations in this economy (give an analytic answer and illustrate your answer in the Edgeworth box).

(c) Describe the competitive equilibrium interest rate and allocations (give an analytic answer and illustrate your answer in an Edgeworth box). The interest rate $r$ is determined by the ratio of the price between consumption next year, $p_2$ and this year, $p_1$:

$$1 + r = \frac{p_2}{p_1};$$

(where you may normalize the price level of this year by setting $p_1 = 1$.)

(d) Describe the contract curve, i.e., the set of Pareto efficient allocations preferred to the endowment point, graphically in the Edgeworth box.