FINAL EXAMINATION

*Write your name and ID number on the front of the blue book. Do not forget to **sign the waiver on the back**. Answer both parts of the exam. Write legibly. Good luck!*

A. Answer both of the following two questions. Show all your work.

QUESTION 1. SOCIAL CHOICE. There are five individuals, A, B, C, D, and E, who have to select among five alternatives labeled v, w, x, y, and z. The individual preference orderings are

A	B	C	D	E
z	w	y	x	v
v	x	x	y	z
y	y	z	w	y
x	z	v	z	x
w	v	w	v	w

(a) Construct the social preference ordering under pairwise majority rule. Is it rational? Why or why not?

(b) Based on your answer in (a), do you think the individual preference orderings are single-peaked? Why?

(c) Plot the individual preference orderings such that they demonstrate your answer in (b). If they are single-peaked, who is the median voter and what would the Median Voter Theorem predict?

(d) Suppose now individual D's preference ordering is $x \succ z \succ w \succ y \succ v$, and the other four are the same as before. What happens to the social preference ordering?

(e) If the individual preference orderings are as in (d) and individual D is the agenda-setter, what would the social choice be? Explain why and how to obtain it.

QUESTION 2. NUCLEAR PROLIFERATION. The United States and the Soviet Union are engaged in a game to decide whether to proliferate nuclear weapons. The United States can choose to give nukes to its NATO allies (D) or control them (C). The Soviet Union can choose to give nukes to its Warsaw Pact allies (D) or control them (C). The payoff matrix is represented in the figure below:

(a) Find all pure-strategy Nash equilibria.

		USSR: Control (C)	USSR: Proliferate (D)
US: Control (C)		$(4,4)$ superpower nuclear monopoly, danger of escalation controlled	$(1,3)$ Warsaw Pact with nukes, NATO forces vulnerable
US: Proliferate (D)		$(3,1)$ NATO with nukes, Warsaw Pact forces vulnerable	$(2,2)$ NATO/Warsaw Pact go nuclear, danger of local escalation

Figure 1: The Proliferation Game.

(b) Let p denote the probability that the US controls, and let q denote the probability that the USSR controls. Find the mixed-strategy Nash equilibrium. What are the expected payoffs in this equilibrium? Show all calculations.

(c) Suppose now the US moves first, followed by the Soviet Union. After each makes its proliferation decision, a crisis erupts between the US and a Soviet protege P. In the crisis, the US can issue a threat (T) or not issue a threat ($\neg T$). If no threat is issued, the protege gets its way, and if a threat is issued, the protege responds by either fighting (F) or not fighting ($\neg F$). Draw the extensive form of this new game. (Hint: you should get 12 outcomes.)

(d) Let r_{US} denote the US payoff from the proliferation game in Figure 1, and let r_{SU} denote the Soviet payoff. For example, if the US played C and the USSR played D, then $r_{\text{US}} = 1$, and $r_{\text{SU}} = 3$. Assign the following payoffs to the outcomes in (c):

- If the outcome is one of the four where no threat is issued, the payoffs are
  - US: $r_{\text{US}} - 2$
  - USSR: $r_{\text{SU}} + 1$
  - Protege with nukes: 3
  - Protege without nukes: 2

  For example, suppose that the US played C and the USSR played D (which means that P has nuclear weapons). Then, if the US plays $\neg T$, the payoffs would be
  - US: $r_{\text{US}}(CD) - 2 = 1 - 2 = -1$
  - USSR: $r_{\text{SU}}(CD) + 1 = 3 + 1 = 4$
  - Protege: 3 (because it has nuclear weapons)
- If the outcome is one of the four where the Protege capitulates (that is, the US plays T and P plays $\neg F$), the payoffs are
  - US: $r_{\text{US}} + 1$
  - USSR: $r_{\text{SU}} - 1$
  - Protege with nukes: 1
  - Protege without nukes: 0
- If the outcome is among the four war outcomes (the US chooses T, and P chooses F), then the payoffs are the expected utilities of war. War can end either in victory for the US or a defeat for the US. The probability that the US wins the war against a protege

that does not have nuclear weapons is 0.8. The probability that the US wins the war against a protege that has nuclear weapons is only 0.1. The payoffs for victory and defeat are given in Table 1:

	US wins	US loses
US	$r_{US} + 3$	$r_{US} - 3$
USSR	$r_{SU} - 3$	$r_{SU} + 3$
Protege with nukes	-4	4
Protege without nukes	-3	3

Table 1: Payoffs from US victory and defeat in war.

Calculate each player's expected utility of war for each of the four possible outcomes where war occurs. For example, $EU_{US}(C, C)$ would denote the US expected utility for war if neither side proliferated in the initial stage of the game.

(e) Find the subgame perfect equilibrium (SPE) for the game in (d) by using backward induction. What is the SPE outcome?

B. Answer any five of the following six questions.

QUESTION 1. Recall that "extended deterrence" refers to situations where a defender pledges to defend a protege against encroachments by some potential challenger. Suppose you read a study that claims that in 80% of extended deterrence cases, the defender fails to protect its protege when challenged. The study concludes that extended deterrence is useless because it fails too often. Discuss.

QUESTION 2. What are the two rationalist explanations of war? Discuss how they demonstrate the possibility of bargaining failure.

QUESTION 3. Explain the principal-agent problem and how it may generate the gamble for resurrection. Give at least one historical example discussed in class where the gamble may have occurred.

QUESTION 4. What is the fundamental problem that mutually assured destruction (MAD) posed for deterrence? What strategies were suggested to overcome it? You may use the Cuban Missile Crisis to illustrate your argument.

QUESTION 5. Explain how cooperation may spontaneously emerge under anarchy. What are some of the problems that have to be overcome to sustain it?

QUESTION 6. What are the two types of **audience costs** and how do they differ from **sunk costs**? Explain how audience costs can affect the credibility of commitments in alliances and during crisis bargaining.