**MSV 805**          **Student Name & ID** _____

**Fall 2017**

**Indian Institute of Technology, Delhi**

**Instructor: Prof. Ranjan Pal**

**Final Examination**

**27/08/2017**

**Time Limit: 180 Minutes**

This exam contains 30 pages (including this cover page) and 4 questions.

## PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. The total exam is worth 300 points.

2. You MIGHT take 15 minutes to go through the question paper and form an attempt strategy. It is advised that you DO NOT start writing in the first 15 minutes.

3. Writing your name and student ID carries TEN BONUS points.

4. There are FOUR sections to this examination.

5. You MAY NOT be able to answer ALL questions, so MANAGE your time WELL.

6. The examination is CLOSED BOOK, and CLOSED NOTES. An A4 CHEAT SHEET is allowed.

7. ALL mobile devices should be SWITCHED OFF.

8. Read the instructions per question very carefully. If required, please raise your hand if you have difficulty understanding any question, or you feel there is a typo error.

9. NO spare sheets will be provided. Use the given space wisely. You can use up all the white space available for BOTH rough work and writing solution steps.

10. PARTIAL CREDIT will be provided where applicable. We will be looking for logical and critical thinking behind every question while providing partial credit.

Grade Table (for instructor use only)

| Question: | 1 | 2 | 3 | 4 | Total |
|---|---|---|---|---|---|
| Points: | 30 | 90 | 90 | 90 | 300 |
| Score: | | | | | |

**Relax and Do Your Best. Good Luck and Have Fun!**

## Section I - Appetizers (30 Points)

1. (30 points) Provide SHORT answers (from a few words to atmost 6 sentences) for each of the following questions. Each question carries 3 points.

   (A) In a variant of the ultimatum game (we call it the *reverse ultimatum game*), A makes an offer to B about how to divide up the 100 dollars. If B says 'yes', the money is divided up and the game is over. But if B says 'no', then A must decide whether to make another offer or not. Each subsequent offer from A MUST be more generous to B. The game ends when either B says 'yes' or A stops making offers, in which case both get a zero payoff. In this case, we can suppose that A will keep on making offers until he has proposed 99 to B and 1 for himself. Thus, according to tree/backward induction logic, B should get almost all of the pie. *If you were a strategic advisor to B, would you advise him to go for a 99:1 ratio in practical reality? Explain your answer.*

   (B) *In game theory parlance, what do the following situations have in common?*

      (a) Two gas stations at the same corner, or two supermarkets in the same neighborhood, sometimes get into fierce price wars with each other.

      (b) In general election campaigns, both the Democratic and the Republican parties in the United States often adopt centrist policies to attract the swing voters in the middle of the political spectrum, ignoring their core supporters who hold more extreme views to the left and the right, respectively.

      (c) The diversity and productivity of New England fisheries was once unequalled. A continuing trend over the past century has been the overexploitation and eventual collapse of species after species. Atlantic Halibut, Ocean Perch, Haddock, and Yellowtail Flounder.. [have joined] the ranks of species written-off as commercially extinct.

(C) Consider the simple British TV show game: two people unable to communicate with each other are each shown a panel of four squares and asked to select one; if and only if they both select the same one, they will each receive a prize. Three of the squares are blue and one is red. *How many Nash equilibria exist in this game? What do you expect to be the outcome(s) when this game is played in practice, and why?*

(D) Parents often face a difficult problem in punishing their children for bad behavior. Children have an uncanny sense of when the parents' threat to punish may not be credible. They recognize that the punishment may hurt the parents as much as the children (although for different reasons). The standard parental dodge to this inconsistency is that the punishment is for the child's own good. *How can parents do a better job at making their threat to punish bad behavior credible?*

(E) My friend, whom we'll call Sue, was in love. Her beau was an extremely successful executive. He was smart, single, and straight. He professed his love to her. It was a happily-everafter fairy tale. Well, almost. The problem was that, at age thirty-seven, Sue wanted to get married and have kids. He was on board with the plan, except that his kids from a previous marriage weren't ready for him to remarry. These things take time, he explained. Sue was willing to wait, so long as she knew that there would be a light at the end of the tunnel. *How could she know whether his words were sincere or not?* Unfortunately, any public demonstration was out of bounds, as the kids would surely find out. What she wanted was a credible signal, i.e., what Sue wanted was something that would help her understand whether he was truly serious about their relationship.

(F) A prospective employer may be concerned about hiring and training a young woman (with an MBA) only to find that she would leave the labor force to have children. Whether legal or not, such discrimination still arises. *How does the woman getting an MBA help solve the problem for the prospective employer?*

(G) One of my colleagues decided to go to an Eminem concert at Saratoga Springs. He was one of the first to arrive and scouted the area for the best place to sit. It had rained recently and the area in front of the stage was all muddy. My colleague settled on the front row closest to the stage yet still behind the muddied area. *Where did he go wrong in his strategic thinking?*

(H) Three antagonists, Larry, Moe, and Curly, are engaged in a three-way duel. There are two rounds. In the first round, each player is given one shot: first Larry, then Moe, and then Curly. After the first round, any survivors are given a second shot, again beginning with Larry, then Moe, and then Curly. For each duelist, the best outcome is to be the sole survivor. Next best is to be one of two survivors. In third place is the outcome in which no one gets killed. Dead last is that you get killed. Larry is a poor shot, with only a 30 percent chance of hitting a person at whom he aims. Moe is a much better shot, achieving 80 percent accuracy. Curly is a perfect shot—he never misses. *What is Larry's optimal strategy in the first round? Who has the greatest chance of survival in this problem?*

(I) One of the more unusual features of a Vickrey (second price) sealed-bid auction is that the winning bidder does not know how much she will have to pay until the auction is over and she has won. In contrast, there is no uncertainty in the more standard first price sealed-bid auction, in which the winner pays her bid. Since everyone knows her own bid, no one has any doubts as to how much she will have to pay if she wins. The presence of uncertainty suggests that we might want to consider the effect of risk on the participants' bidding strategies, in reality. The typical response to uncertainty is negative: the bidders are worse off in a Vickrey auction because they do not know how much they will have to pay if they have submitted the winning bid. *Is it strategically reasonable that a bidder will respond to this uncertainty or risk by lowering her bid below the true valuation? Explain.*

(J) Two companies, one in Dallas and one is San Francisco, were using the same New York–based lawyer. As a result of coordinating their schedules, the lawyer was able to fly NY–Houston–SF–NY, a triangle route, rather than make two separate trips. The one-way airfares were: NY-Houston ($666), Houston-SF ($909), SF-NY ($1243). The total cost of the trip was $2,818. Had the lawyer done each of the trips separately, the round-trip fares would have been just double the one-way fares (as there was no time to book the trip in advance). *Our question considers how the two companies might negotiate the division of the airfare. Explain an appropriate negotiation logic.*

## Section II - Settling In (90 Points)

2. (90 points)  Solve the following questions in the space provided. For these questions, correctness will be given majority importance.

   (i) (15 points) Jet Airways and Etihad have entered into a strategic partnership that includes code sharing since 2013.  Assume the deal includes a revenue pool on the route between Abu Dhabi and Chennai.  By this arrangement, each airline must pass half of its revenue to the other airline, but bear all of its operating costs. Suppose that both airlines charge INR 20,000 for a round trip economy fare and that each airline sells 4000 tickets per week.  If any airline offers discounts by cutting fares 10 per cent, it can increase sales by 2000 tickets, provided the other airline maintains its price. If both airlines cut fares by slashing ticket prices by 10 per cent, then each would increase sales by 500 tickets.  If only one airline cuts price, it will attract additional passengers who would most likely be divided between new flyers and switchers from the other airline. If both airlines cut fares, all the additional passengers would most likely be new flyers. Assume that both airlines have the same cost structure: fixed cost of INR 1 million and average variable cost of servicing each passenger fixed at INR 5,000.

   (a) For each airline, the possible strategies are to maintain price or to offer discounts of 10 percent.  Assume there is no revenue pool to begin with and each airline acts independently.  Use a game theoretic form or normal form to analyse the situation. *What will be the equilibrium outcome?*

   (b) Now, with the introduction of the revenue pool, use a game in strategic form (normal form) to analyze the situation. *What will be the equilibrium outcome now?*

   (c) *Is code-sharing a good strategy for the two airlines?*

(ii) (15 points) Suppose two firms, Amul and Anik are competing in the market for tetra pace milk. The firms can charge either a low price of INR 20 per litre or a high price of INR 40 per litre. The costs for the two firms are the same at INR 10000. With a lower price, the firms are able to sell a total of 1000 tetra packs as compared to 500 packets sold at a higher price. If the two firms charge the same price, they split the market, with each firm getting half of the sales. If one form charges a low price and the other firm charges a high price , the firm charging a lower price gets the entire market and the firm charging a higher price is unable to sell anything in the market.

(a) *Represent the game as a normal form game with profits as the payoffs.*

(b) *What is the Nash equilibrium of the game?*

(c) *Is this game a zero-sum or a positive-sum game?*

(iii) (15 points) Let there be a monopolist in the market for computer chips, say Intel that earns revenues worth $100 million. Now, a smaller chip-maker AMD thinks of entering the market, but in order to do so, it will have to incur a sunk cost of $30 million. If AMD enters the market and Intel accommodates the entry, both companies will split the market equally. If however, Intel decides to fight entry with capacity expansion and low prices, then Intel will have to bear a cost of $20 million, but will also increase its market share by $10 million. The lower price in the market will dent AMD's revenues by $30 million.

   (a) *Draw the game tree for this game where AMD has to decide whether to enter or stay out and Intel has to decide whether to fight or accommodate if AMD enters.*
   (b) *Should AMD enter or stay out?*
   (c) *If Intel retaliates, will the strategy be effective in deterring AMD's entry?*

(iv) (15 points) JetKonnect is the only airline operating on the Chennai-Trichy route usign the 72-seater ATRs for its flights. Business travellers are willing to pay up to INR 10,000 for a same-day return ticket. Vacation travelers are more flexible and willing to pay at most INR 4,000 for a round-trip irrespective of returning the same day. Since, the airline cannot determine whether a passenger is a business or vacation traveler, it charges INR 4,000 as the round trip-fare for all flights. Assume the percentage of travelers going on business and vacation is the same for all the flights.

(a) *As the sales manager of JetKonnect, can you devise a mechanism to distinguish between the two types of travelers?*

(b) *Can this scheme improve the revenues for the airline? Explain.*

(v) (15 points) According to a newspaper report, the value of Late M.F. Hussain's paintings have increased sharply *(source: Economic Times, August 23, 2012)*. The owner of a rare Hussain painting wants to sell through an auction. There are only two bidders for the painting, Anushka and Bipasha. The painting is worth INR 4 crore to Anushka and worth INR 2 crore to Bipasha. Answer the following questions:

    (a) *Consider the case where the current owner of the painting wants to sell the painting through an English auction with the rule that no ties are allowed and the winning bid has to be strictly higher than the other bid. Write down Anushka's payoff functions and Bipasha's payoff function.*

    (b) *Now, consider the case when the owner of the painting wants to sell the painting through a second price sealed bid auction with the rule that a tie is allowed and the winner will be decided through a lottery. How will it change the bidder's payoff functions in part (a)?*

    (c) *If Bipasha somehow gets to know that Anushka will bid INR 7 crore for the painting, she decides not to bid at all. Is this an equilibrium outcome in a second price sealed bid auction?*
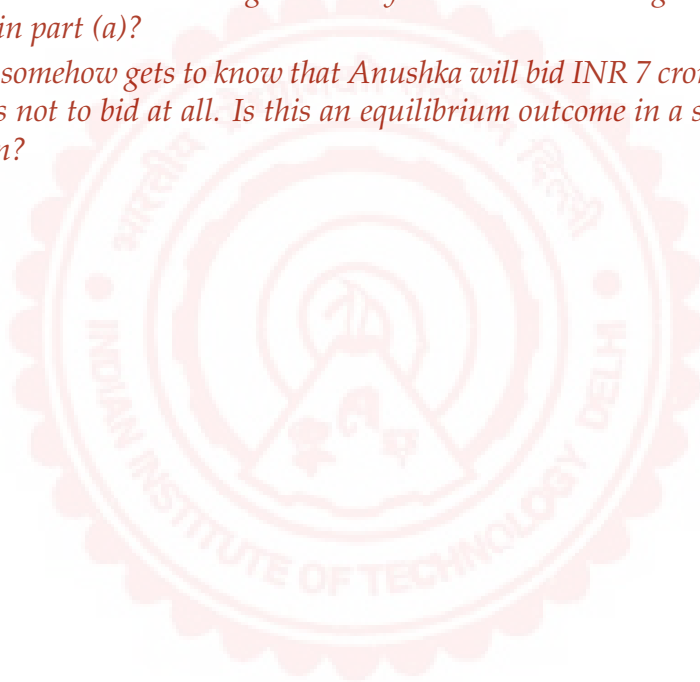
(vi) (15 points) Let us assume that Reliance Telecom and social media service Facebook, wants to join hands to launch Free Basics mobile app in India. Reliance Telecom has the advantage of an established base of subscribers. If Reliance Telecom joins Free Basics by Facebook, Indian subscribers can get free access to the web. If Reliance Telecom does not agree to the deal, it can earn INR 10 crore on its own. Without Reliance Telecom, Facebook can earn INR 90 crore. If the two firms enter into a partnership, they can promote development through web-based businesses and generate revenues worth INR 150 crore.

(a) *What is the value created by the contract?*

(b) *Assume the law firm that acts as the arbitrator for the deal proposes a split of 1:3. If surplus for Facebook is thrice that for Reliance Telecom, how much will each firm get from the deal?*

# Section III - A Suit of Cases (90 Points)

3. (90 points) Analyse the following SIX cases using principles from game theory. Project the game that is being played, AND/OR the aspect of game theory under consideration, and provide a description on the outcome of the game. Be precise in your reasoning.

    (i) (15 Points) OPEC was formed in 1960 as a cartel between five crude oil exporting countries—Iran, Iraq, Kuwait, Saudi Arabia and Venezuela. At present, there are 12 member countries of OPEC—Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates and Venezuela. The stated mandate of OPEC is to 'coordinate and unify the petroleum policies' of its member countries to 'ensure the stabilization of oil markets' in order to 'secure an efficient, economic and regular supply' to consumers, 'a steady income to producers' and a 'fair return on capital for those investing in the petroleum industry'.

As of 2013, 81 per cent of world's proven oil reserves were located in OPEC member countries, amounting to 1,207 billion barrels. However, OPEC's market share is about 40 per cent. Clearly, OPEC is in no hurry to drill its reserves. The oil quality is not the same across the output of different OPEC countries. Venezuela and Iran produce heavy crude vis-à-vis the light crude of Saudi Arabia, Iraq and Nigeria. OPEC Reference Basket of Crudes (ORBC) price is a weighted average price of crude produced by different member countries. Having 40 per cent market share, ORBC price is an important benchmark in the oil industry. In order to have control over global crude price, OPEC must have perfect control over ORBC, and in order to do that OPEC sets weekly crude output quota for its member countries.

If a member country defects from its given quota, then that country is first warned, and if they continue to defect, the country's membership of OPEC is suspended for a period. Later, evaluating that country's production pattern during the period of suspension, OPEC decides whether to renew the country's membership or to terminate it. Ecuador was suspended from December 1992 until October 2007. Indonesia is suspended since January 2009. The membership of Gabon was terminated in 1995.

(ii) (15 points) A team of researchers led by Steffen Andersen from Copenhagen Business School conducted an experimental ultimatum game with varying stakes. The participants were villagers from eight different villages of Meghalaya, a state in the northeast of India. The participants were daily wage earners and had little wealth of their own. There were a total of 916 participants, who were divided into two equal groups—one group consisting of participants who were asked to play the role of 'proposers' and another group of those who were asked to play the role of 'responders'. Four hundred fifty eight pairs played the ultimatum game with four different orders of stakes— INR 20, INR 200, INR 2,000 and INR 20,000.

Considering INR 100 as the average daily wage earned by the participants, the stakes correspond to 1/5th of a day's work, 2 day's work, 20 day's work and 200 day's work, respectively. Since the participants normally don't work every day, or they don't find work every day, INR 20,000 correspond to more than a year's earning given that the average annual earning of the participants was INR 17,000. In that scale, INR 2,000 was close to their earning in one and half months, '200 was more than their earnings in four days and INR 20 was more than what they earned in three hours on an average. In order to test if there is any significant 'wealth effect', that is, if the behaviour depends on how rich the participant is, the researches gave an initial earning from unrelated task to 322 pairs of participants.

Out of these 322 pairs, 173 pairs played the game with INR 20 at stake, 74 pairs with INR 200 at stake, 63 pairs with INR 2,000 at stake and 12 pairs with INR 20,000 at stake. Of the remaining 136 pairs with no initial earnings, 28 pairs played the game with INR 20 at stake, 50 pairs with INR 200 at stake, 46 pairs with INR 2,000 at stake and 12 pairs with INR 20,000 at stake. In order to make sure that the participants can apply backward induction, the researchers provided a cue to them. Basically, the logic of looking forward and reasoning backward was explained to the participants in the context of the game they were asked to play.

The results clearly showed that there is an inverse relation between the average share offered by the 'proposers' and the stake involved. While the average share offered was close to 25 per cent in the games with INR 20 at stake, it reduced to 17 per cent in games with INR 200 at stake, to 14 per cent in games with INR 2,000 at stake and to 12 per cent in games with INR 20,000 at stake. While the density of offers was highest in the 20–30 per cent range for the games with INR 20 and INR 200 at stake, it was highest in the less than 10 per cent range for the games with INR 2,000 and INR 20,000 at stakes. Indeed, the absolute offers increased with increase in stake. The median value of the actual offer increased from INR 5 in the INR 20 stake game to INR 30, INR 200 and INR 1,500 in the games with stakes of INR 200, INR 2,000 and INR 20,000, respectively. The researchers also found that there is not much effect of initial wealth that some pairs of participants were given.

The rejection rate of 'responders' decreased as stakes increased. While 36.32 per

cent of offers were rejected in the game with INR 20 at stake, the rejection rate dropped to 4.17 per cent (only 1 out of 24 'responders' in that stake category) in the game with INR 20,000 at stake. The pattern of the decreasing rate of rejection with increasing stakes holds for both participants with initial wealth and those with no wealth. But for the participants with initial wealth, the rejection rate increased from 35 per cent in the game with INR 20 at stake to 47 per cent in the game with INR 200 at stake. The most important finding from the study was that the rejection rate decreased and approached zero as the amount of money that needs to be foregone due to the rejection increased.

(iii) (15 points) In 1997, Walmart entered Germany by acquiring two unprofitable retail chains—Wertkauf and Interspar. These two chains had only 3 per cent share in the German retail market. In order to compete against Metro AG and Rewe Group, the two largest retail chains in Germany, Walmart emulated its US market strategy known as "Everyday low prices". Metro AG and Rewe Group responded by lowering prices. In September 2000, the Federal Cartel Office accused Walmart and its two biggest German rivals of selling about a dozen staple products like milk, butter, vegetable oil, etc., at prices below respective average costs. A fine of one million deutsche mark was slapped on Walmart. The products in question are what Walmart classified as "corner products". As a strategy Walmart used to price these corner products very low everywhere. As per Walmart's understanding, the consumers know the prices of these items with other retailers, and if these items are priced low it creates a general impression of low price with the consumer. Indeed the slogan "Save Money Live Better" made Walmart the largest retailer in the USA. Walmart appealed against the accusation of predatory pricing. But the Supreme Court of Germany ruled in January 2003 that Walmart violated the country's anti-trust laws with their below-cost pricing strategy. The ruling stated that the authorities feared that a price war among the big three retailers will decimate the momn- pop stores leaving the consumers with fewer choices.

Around the same time Crest Foods, a three-store chain of food items retailer in Oklahoma City in the USA filed a predatory pricing suit against Walmart. Edmond Walmart Supercentre opened in Oklahoma City on 18th May 2000. Allegedly, on 23rd May 2000 a team of Walmart personnel including former president Mr David Glass visited Crest Food and scanned their prices using a hand-held device. Later, during their investigation, law firm Crowe and Dunlevy found that Edmond Walmart Supercentre was beating Crest in prices of 25 items, while Crest was beating other Walmart supercentres in 22 items. Edmond Walmart Supercentre was beating other Walmart supercentres in prices of 28 items. It was cited as an example that on 9th June 2000, French Mustard sold for 88 cents in Crest, while in Edmond Walmart Supercentre the same item sold for 50 cents. However, on that very day the same item was priced in the range of 88 cents to 97 cents in other Walmart supercentres in Oklahoma City and nearby areas. Crowe and Dunlevy concluded that Walmart's pricing resulted in 20 per cent sales drop for Crest Foods, which amounted to a damage of 3 million dollars in a span of three months.

While the trouble was brewing for Walmart in Oklahoma, Wisconsin Department of Agriculture, Trade and Consumer Protection charged Walmart with selling staple goods like milk, butter, detergent, etc., at prices below cost in several stores within the state of Wisconsin, which violated the state's antitrust laws. The complaint stated that Walmart intended to force other stores out of business, gain monopoly in local markets and ultimately recoup its losses through higher prices in future.

(iv) (15 points) On June 11, 2008, Ranbaxy and Daiichi Sankyo entered into a merger deal to create a hybrid model of an innovating partner and a generic partner. Ranbaxy had offers from other companies prior to this including GlaxoSmithKline, Takeda, Sanofi-Aventis, and Pfizer. But, Daiichi Sankyo said it would raise the offer in case of competition since Ranbaxy's stakeholders had shown their willingness to sell to the highest bidder. As part of the deal, Daiichi Sankyo paid $2.4 billion for 34.8 per cent stake in Ranbaxy. By November 2008, Daiichi Sankyo acquired the entire stake from the promoters of Ranbaxy for $4.6 billion. This worked out to 20 times Ranbaxy's operating profits for the year 2007 and a 53.5 per cent premium over the company's average daily closing price for the quarter ending June 10, 2008.

The deal had ominous potents right from the start when Ranbaxy's share prices fell after the announcement of the merger and the downfall continued for the next three quarters. That was not all, for the first time in the history of the company, it saw net losses consecutively for three quarters since the 2008 announcement. This happened despite the fact that prices of Ranbaxy's drugs had gone up by 0.4 per cent after the takeover. There was more trouble brewing. In December, 2011, the US Department of Justice filed a consent decree against Ranbaxy and the US FDA banned imports of its drugs. It was alleged that Ranbaxy had fraudulently submitted false records and indulged in contamination of drugs. Ranbaxy had to close down its plants that were supplying to the US as well as agree to pay $500 million as part of the consent decree. It also agreed to forego any 180-day marketing exclusivity that it might have had for three pending drug applications. The immediate fall-out of the settlement was that Ranbaxy's share prices fell by nearly 7 per cent, making it the biggest loser on the 50-member S&P CNX Nifty index. According to Wall Street analysts, Ranbaxy's intractable manufacturing difficulties had made the Daiichi Sankyo deal a failure. As a response to the cut in earnings forecast, Daiichi Sankyo had to go in for a six-month pay cut for its executives and directors.

Ultimately, the deal or rather the ordeal for Daiichi Sankyo ended with Sun Pharma agreeing to buy the beleaguered company for $3.2 billion in 2014. It also agreed to buy out the company's debt of $800 million.

(v) (15 points) In December 2015, leaders of 196 countries of the United Nations Framework Convention on Climate Change were slated to meet in Paris to agree on a deal to reverse climate change that will come into effect in 2020. The objective of the summit was for all countries to cooperate in reducing global warming to two degrees from pre-industrial times.

In earlier agreements, targets were set and national governments were asked to meet those targets. The previous summit at Copenhagen in 2009 failed to reach an agreement, mainly due to the intransigence of China and India. This time round, there was a strong will for the deal to go through with a bottom-up approach. Individual countries had been asked to come up with their own proposals that add up to significant reductions in carbon emissions. Since efforts to reduce carbon emissions take time and are cumulative in nature, greater cooperation would mean less effort would be required in future. As UN's climate official, Christiana Figueres said, "It was not meant to be a one-shot deal" There was a call for countries to recognize their responsibility in the light of changing economic realities. This was in contrast to the 1997 Kyoto Protocol that allowed emerging countries like China and India to do nothing, while industrialized countries had to abide by emission targets.

By the end of 2014, China and the US had brokered a deal on carbon emissions. The US President, Barack Obama in his second term had made climate change an important policy focus. He announced a plan to cut carbon emissions by a third over the next 15 years. The Chinese Premier, Xi Jinping announced a national scheme to implement carbon pricing in 2017 and cut emissions intensity by two-third. The Indian prime Minister, Narendra Modi, in accordance with the concept of 'differentiated responsibility', committed to cut the emissions intensity by one-third by 2030 from 2005 levels. By October 2015, as many as 146 countries had submitted their plans, including top emitters such as China, the US, and India.

(vi) (15 points) The year 2014 started with the President of India giving assent to the Lokpal and Lokayukta Bills, 2013. The Bill provided for an ombudsman to investigate graft charges against public officials, including the Prime Minister with some safeguards. The Bill had been passed in the Lower House of the Parliament in 2011, but could not be voted upon in the Upper House and was referred to a Parliamentary Standing Committee. The amended Bill was voted upon on December 16, 2013 and passed by voice-vote in the Upper House, after which it was again sent to the Lower House before being sent for a Presidential assent.

In a rare display of unity, both the mainstram parties, the ruling Congress party and the BJP-led opposition, passed the Bill in the Lower House without any debate on December 17, 2013. This was surprising, since eight unsuccessful attempts had been made to set up an office of the corruption ombudsman over the last five decades. The first attempt was made in 1966 by the then Prime Minister, Morarji Desai, who was the chairperson of the first Administrative Reforms Commission that recommended a Lokpal at the centre and Lokayuktas for the states to look into corruption charges for the Members of Parliament and other public officials.

What was different this time round was the public anger against corruption, which was given the form of a movement by activist Anna Hazare. He went on a fast that lasted nine days and was broken with the passage of the Bill. Added support to the anti-corruption campaign came after the Aam Aadmi Party (AAP) led by Arvind Kejriwal trounced the Congress in the Delhi State elections which were widely seen as a prelude to the general elections to be held in May 2014. The AAP had won the elections on the platform of cleaning up corruption in public offices; its symbol was the broom and its leader was a key member of Team Anna that crusaded against corruption.

After the passage of the Bill, Congress Vice-President, Rahul Gandhi, in an exchange of letters with Hazare wrote, "All of us are committed to provide people of this country a competent and strongest possible Lokpal system." The mood of the electorate could not longer be ignored.

# Section IV - Hot and Spicy ! (90 Points)

4. (90 points) This sections consists of TEN problems. You MAY NOT be able to do all the questions. Do AS MANY as you can. Please show working and above all a good logic.

 (i) (9 points) Recall the "beach vendors" game we discussed in class, with the following modification: there are two firms (i=1,2), each one chooses a position from the set $S_i = \{1, 2, ..., 10\}$. The consumers are equally distributed across these ten positions. Consumers buy from the firm whose position is closest to theirs. If the two firms are equidistant from a given position, half of the consumers go to each firm. The aim of the firms is to maximize their total sales. Thus, for example, firm 1's payoff if both firms choose position 8 is $u_1(8, 8) = 50$. If instead, firm 1 chooses 7 and firm 2 chooses 8, firm 1's payoff is $u_1(7, 8) = 70$. [Hint: you do not need to write out the full payoff matrix!]

 (a) Consider the strategy of picking location 1. *Find all the strategies that strictly dominate strategy 1.* Explain your answer. [Hint: try some guesses and see if they work.]

 (b) Suppose now that there are three firms. Thus, for example, $u_1(8, 8, 8) = 33.3$ and $u_1(7, 9, 9) = 73.3$. *Is strategy 1 dominated, strictly or weakly, by strategy 2? How about by strategy 3? Explain.*

 (c) Suppose we delete strategies 1 and 10. That is, we rule out the possibility of any firm choosing either location 1 or 10, although there are still consumers at those positions. *Is strategy 2 dominated, strictly or weakly, by any other strategy $s_i$ in the reduced game? Explain.*

(ii) (9 points) Players 1 and 2 are bargaining over how to split \$10. Each player $i$ names an amount, $s_i$ between 0 and 10 for herself. These numbers do not have to be in whole dollar units. The choices are made simultaneously. Each player's payoff is equal to her own money payoff. We will consider this game under two different rules. In both cases, if $s_1 + s_2 \leq 10$ then the players get the amounts that they named (and the remainder, if any, is destroyed).

(a) In the first case, if $s_1 + s_2 > 10$ then both players get zero and the money is destroyed. *What are the (pure strategy) Nash Equilibria of this game?*

(b) In the second case, if $s_1 + s_2 > 10$ and the amounts named are different, then the person who names the smaller amount gets that amount and the other person gets the remaining money. If $s_1 + s_2 > 10$ and $s_1 = s_2$ then both players get \$5 . *What are the (pure strategy) Nash Equilibria of this game?*

(iii) (9 points) You're at a job interview and you are requested to make a simple deci-sion. The interviewer says, "I have a \$1 bill and a \$5 bill, which one would you like? Don't worry, if you make the wrong choice, I'll give you an extra \$5. What is your choice?"

You think carefully about the problem. It looks like the interviewer is trying to check if you can reason out a little bit. You think, only a fool would take the \$5 and be greedy. The smart choice must be to take the smaller \$1 bill. Then the interviewer would inform you that you made the wrong choice, and he'd give you an extra \$5. In the end, you'll have \$6 and more money than if you took the \$5 bill.

But just as you're about to indicate your answer, a thought strikes you. If the \$1 bill ultimately nets more money, wouldn't that make the \$5 bill the wrong choice? Using that logic, you realize you should probably take the \$5 bill.

Now it gets interesting. If you think taking the \$5 bill is the right choice, then that means taking the \$1 bill was the wrong choice, and hence your first instinct was right! *Explain the paradox*.
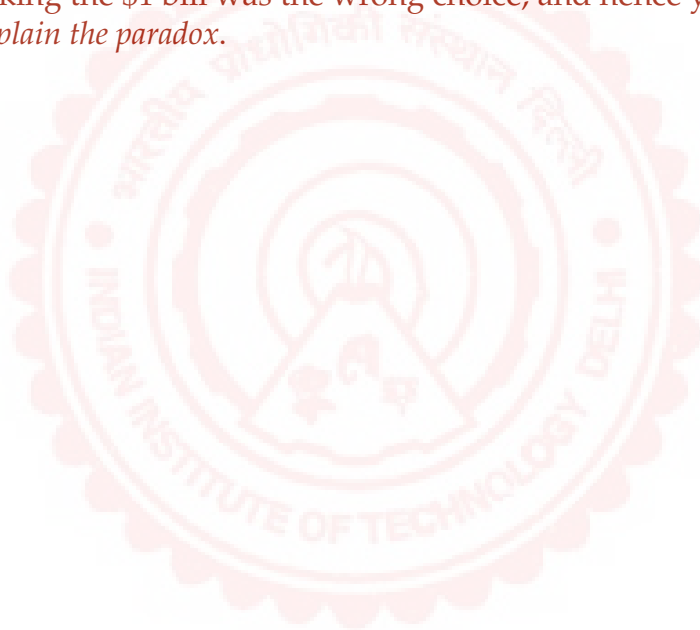
(iv) (9 points) Bill Gates meets Warren Buffett at a dinner party and the host tells them to play a game. Each person will place his wallet on the table. The person with less money in his wallet wins all the money. Is anyone favored to win this game? What happens when the game is repeated?

At first glance, the game seems favorable for Bill Gates. He might think as follows. He could either have more or less money, so he has a 50/50 chance of winning the game. If he loses, then he would lose only the money in his wallet. If he wins, however, then he would win more money than what he has in his wallet. That is, Bill Gates can wager the money in his wallet (say x dollars) and have a 50 percent chance of winning the money in Warren Buffett's wallet, which is more than x dollars. This is obviously a winning gamble, and thus Bill Gates will want to play as he seems favored.

On the other hand, Warren Buffett thinks about the game. By symmetry, he can reason exactly the same thing. He feels that he has an even chance of winning more money than he has in his wallet, and thus he is favored by the game.

Both billionaires find the game advantageous. And yet this cannot be. The game is a zero-sum game (the profits of one are exactly the losses of another) and thus it is impossible for both to expect a profit at the same time. *How can we resolve the reasoning and resolve the apparent paradox?*
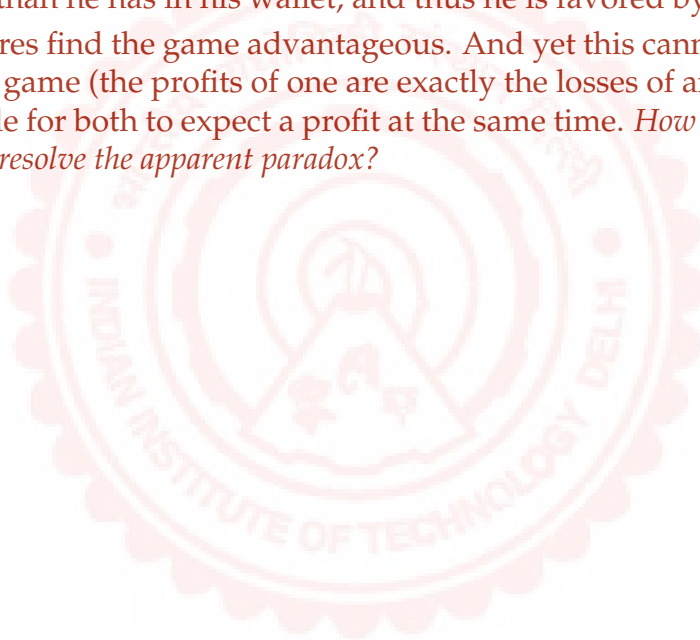
(v) (9 points) A traveler gets lost on a deserted island and finds himself surrounded by a group of $n$ cannibals. Each cannibal wants to eat the traveler but, as each knows, there is a risk. A cannibal that attacks and eats the traveler would become tired and defenseless. After he eats, he would become an easy target for another cannibal (who would also become tired and defenseless after eating). The cannibals are all hungry, but they cannot trust each other to cooperate. The cannibals happen to be well versed in game theory, so they will think before making a move. *Does the nearest cannibal, or any cannibal in the group, devour the lost traveler?*

(vi) A group of 5 pirates is dividing up 500 gold coins. How will they split the treasure? The pirates are a disciplined and logical group, and they have a custom of how to split up treasure. The 5 pirates (A, B, C, D, and E) have a strict organization by strength: pirate A is the strongest, followed by B, then C, then D, and then E. The voting process is a series of proposals with a lethal twist. Here are the rules:

- The strongest pirate (A) offers a split of the gold. An example split is: "450 to A (me), 10 to B, 20 to C, 10 to D, and 10 to E."
- All of the pirates, including the proposer, vote on whether to accept the split. In the case of a tie, the proposer holds the casting vote to break the tie.
- If the pirates agree to the split, it happens.
- Otherwise, the pirate who proposed the plan gets thrown overboard from the ship and perishes.
- The next strongest pirate takes over and then offers a split of the money. The process is repeated until a proposal is accepted.

Pirates care first and foremost about living, then about getting gold. If a pirate is indifferent between saying "Yes" and "No" to a split in terms of money, then the pirate votes "No" because the pirate prefers to eliminate stronger pirates. *How does the game play out?*
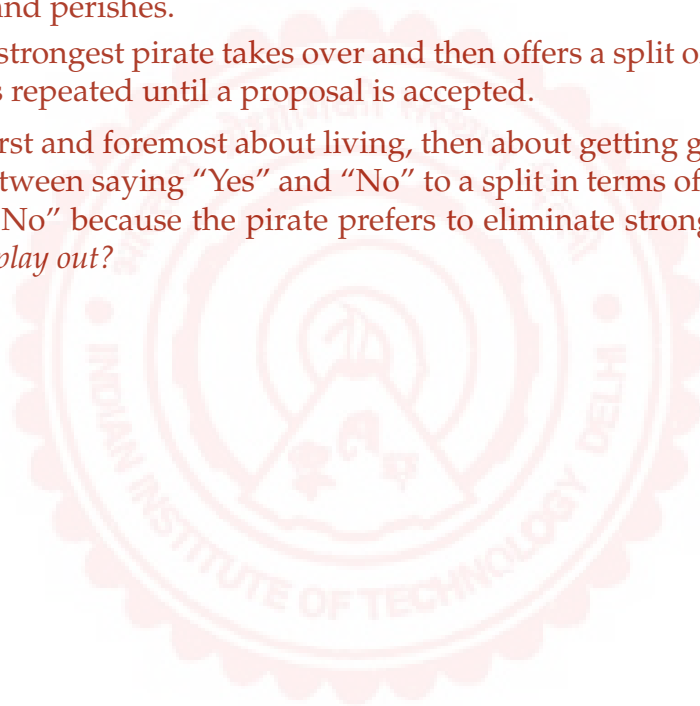
(vii) (9 points) Professor Martin Shubik of Yale University designed the following game of entrapment. An auctioneer invites bids for a dollar. Bidding proceeds in steps of five cents. The highest bidder gets the dollar, but both the highest and the second highest bidders pay their bids to the auctioneer. Professors have made tidy profits—enough for a lunch or two at the faculty club—from unsuspecting undergraduates playing this game in classroom experiments. Suppose the current highest bid is 60 cents and you are second with 55. The leader stands to make 40 cents, but you stand to lose your 55. By raising to 65, you can put the boot on the other foot. The logic is no different when the leading bid is $3.60 and yours is $3.55. If you do not raise the bidding still further, the "winner" loses $3.60, but you lose $3.55. *How would you play this game?*

(viii) (9 points) Alice and Bob are on a game show. Each is secretly told a whole, positive number. They are told the two numbers are consecutive, but neither knows the other person's number. For example, if Alice is told 20, she does not know if Bob was told 19 or 21. And if Bob is told 21, he does not know if Alice was told 20 or 22. The point of the game is to guess the other person's number. The game works as follows.

- Alice and Bob cannot communicate with each other, and they are not allowed to plan their strategy either.
- The two are in a room where a clock rings every minute.
- After the clock rings, either player can call out a guess of the other player's number, or they can stay silent.
- The game continues until Alice or Bob makes a guess. After the first guess is made, the game ends.
- Alice and Bob win $1 million each if the guess is correct, and they lose and get nothing if the guess is incorrect.

*How should Alice and Bob play this game to have the best chance of winning?* Each knows the other person is perfect at logical reasoning.
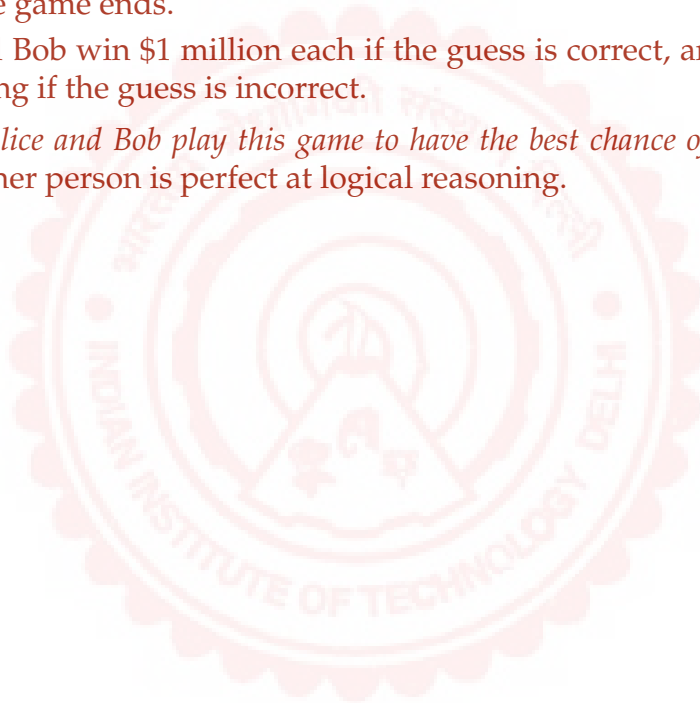
(ix) (9 points) Consider the Market Entry game we saw in class: an Entrant must choose whether to go "In" or "Out" of the market. If the Entrant goes In, the Incumbent must choose whether to Fight or Not. Choosing In involves a fixed, sunk cost of 5 for the Entrant. The following payoffs do not include the sunk cost. If the Entrant goes In and the Incumbent fights, they both receive a payoff of 4. If the Incumbent does not fight, they both receive a payoff of 10. If the Entrant stays out, it saves the fixed cost and gets 0, while the Incumbent gets 20.

*Draw the game tree and the payoffs at each terminal node.*

Now imagine that before the game is played, the Incumbent can make an investment. Each investment opportunity entails an up-front cost and modifies the payoffs in the ensuing game. The Incumbent must choose one of the three following options:

- Lobby for tighter regulation. This costs 2 to the incumbent, and increases the Entrant's fixed cost of choosing In from 5 to 8.
- Improve its technology so to better tolerate a price war. This costs 8 to the Incumbent, and increases its payoff of Fighting from 4 to 12. (No change to the other payoffs).
- Advertising campaign that shifts 2 units of profits from the Entrant to the Incumbent whenever the Entrant chooses In. The campaign costs 1.

*Evaluate the three investment opportunities and find the one with the highest return to the Incumbent.* (Hint: do not draw out a huge three with the Incumbent's initial move, just modify the game tree with the new payoffs.)

(x) (9 points) Two venture capitalists want to fund a project. There are two possible projects, and each VC only has resources to fund one. Two entrepreneurs arrive sequentially and pitch their ideas to the VCs (who are sitting in the same room). Each entrepreneur's idea has a net present value V that is uniformly distributed between 0 and 10. VCs don't know the exact value of an idea until they hear the pitch. Upon hearing the first entrepreneur's pitch, both VCs must simultaneously announce "yes" or "no." If only one says yes, she earns the value V of that idea, and leaves the game. If both say yes, a 50:50 coin flip determines which VC gets to fund the entrepreneur, and which one stays in the game. Whoever is left in the game (i.e., one or both VCs) gets to hear the second entrepreneur's pitch, and decide whether to fund it. There is no value for a VC in ending the game without funding a project.

(a) Suppose for a moment there was only one VC. Use backwards induction. *Which ideas should he fund in the second period if he says "no" to the first one?*

(b) Consider the single VC's plan of action for the whole game. *Fill the blanks. "In the first period, I will fund the following ideas: .............................."*

(c) Now consider the game with two VCs. In order to apply backwards induction, you must compute the following two key values: *what is the expected payoff of a VC who enters the second period alone (which occurs if the other VC funds the first idea)? And what is the expected payoff of both VCs entering the second period (which occurs if both say no to the first idea)?*