INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR
Department of Humanities and Social Sciences
End-Autumn Semester Examination - 2022-23

Full Marks: 50

Date: November 2022

Sub. Code: HS50025

Time:

International Finance

Answer **all** the questions

Assume values in case required

No queries during the examination

Q1-4: 2 marks each; Q-5-10: 5 marks each; Q11: 12 marks

1. An subsidiary of Adani group located in the London is having £ 100 million asset exposure. List the possible balance sheet hedging choices through which the firm can hedge the risk or reduce the exposure.

2. List the factors responsible for home bias among foreign investors.

3. State how a swap instrument can be a synthetic investment instrument from a seller's point of view?

4. Graphically illustrate the pay-off structure of bond put option both in terms of price and yield.

5. Voice Mail Inc. exports voice mail systems from the United States, where it is based and the systems are constructed, to the United Kingdom. It has invested (US dollars) USD 300,000 domestically in this export business. In 2022, voice mail system cost USD 500 to build and was sold for (British Pound) GBP 520 and exchange rate was 0.65 GBP/USD. The firm exports 100 units. Its British competitor (located in the UK) would also be selling the similar products at GBP 520.

   (a) Please calculate profit margin and return on investment.

   (b) Suppose inflation is 3% in the US and 8% in the UK over the next year. Illustrate effect of this on Voice Mail Inc.'s operations, if exchange rate moves exactly according to purchasing power parity principle.

   (c) Consider the case where there is a real appreciation of the dollar and exchange rate becomes 0.7000 GBP/USD and Voice Mail Inc. choose to set its UK price equal to the price of its UK competitors. What will be its effect on profit margin and return on investment of the firm.

   (a) What are the net proceeds to Siemens from each of these syndicated loan proposals?

(b) Assuming that six-month SOFR is currently at 4.35%, what is the effective annual interest cost to Siemens for the first six months of each loan?

6. Suppose McDonald must make a payment denominated in Japanese yen (JPY) equal to JPY 100,000 in six months. Information on money markets, the exchange markets, and expectations of exchange traders is as follows:

Money Market	
United States	5% annual rate of interest
Japan	11% annual rate of interest
Exchange Market	
Spot	100 JPY / USD
Six months forward	103 JPY / USD

Illustrate cost and benefits of uncovered, forward hedge and money market hedge strategies to McDonald.

Handwritten annotations: $A\ B\ C$; $1 USD = 103 JPY$; $1 JPY = \frac{1}{103} USD$; $(1+r_d) = P(1+r_f)$; 102.9268293 ; $5/2$; $11/2$

7. Dell Computers would like to borrow pounds, and United Airlines wants to borrow dollars. Because Dell is better known in the United States, it can borrow on its own dollars at 7% and pounds at 9%, whereas United Airlines can on its own borrow dollars at 8% percent and pounds at 8.5%.

(a) Suppose Dell wants to borrow £10 million for two years, United Airlines wants to borrow $16 million for two years, and the current ($/£) exchange rate is $1.60. What swap transaction would accomplish this objective? Assume the counterparties would exchange principal and interest payments with no rate adjustments.

(b) What savings are realized by Dell and United Airlines

8. Assume that the swap rate for an interest rate swap is 7% and that the fixed-rate swap payments are made quarterly on an 'actual/360 basis.'

(a) If the notional amount of a 2-year swap is $20 million, what is the fixed-rate payment at the end of each quarter assuming the following number of days in each quarter:

(b) Assume that the swap in part (a) requires payments semiannually rather than quarterly. What is the semi-annual fixed-rate payment?

(c) Suppose that the notional amount for the 2-year swap is not the same in both years. Suppose instead that in year 1 the notional amount is $20 million, but in year 2 the notional amount is $12 million. What is the fixed-rate payment every six months?

Period Quarter	Days in Quarter
1	$92
2	$92
3	$90
4	$91
5	$92
6	$92
7	$90
8	$91

9. An investor holds a portfolio of $10 million of risk bonds on each of the following three companies. Assume that we know the recovery rate for each bond in advance:

   (a) Firm A with a recovery rate of 40 %

   (b) Firm B with a recovery rate of 30 %

   (c) Firm C with a recovery rate of 50 %

   If the investor uses CDS to protect her $30 million investment, how much would she receive in each of the following scenarios?

   (a) Firm B defaults in a standard CDS

   (b) Firm B defaults in a first to default basket

   (c) Firm A defaults, followed by firm B in a first to default basket

   (d) Firm C defaults in a senior basket with a $5 million first-loss limit

   (e) Firm A defaults in a senior basket with a $5 million first-loss limit.

10. Suppose that IBM would like to borrow fixed-rate yen whereas Korea Development Bank (KDB) would like to borrow floating-rate dollars. IBM can borrow fixed-rate yen at 4.5 percent or floating-rate dollars at SOFR + 0.25 percent. KDB can borrow fixed-rate yen at 4.9% or floating-rate dollars at SOFR + 0.8%.

    (a) What is the range of possible cost savings that IBM can realize through an interest-rate/currency swap with KDB?

    (b) Assuming a principal equivalent to USD 125 million, and a current exchange rate of Yen 105/USD, what do these possible cost savings translate into in yen terms?

    (c) Redo Parts a and b assuming that the parties use Bank of America, which charges a fee of 8 basis points to arrange the swap.

11. General Motors wants to raise $100 million of 3-year debt in the Euromarket (where interest is quoted and paid on an annual basis). Its alternatives are either a 3-year

3 of 4

fixed rate note at a spread of 250 basis points over the 3-year U.S. Treasury (currently yielding 4.50 %) or a 3-year floating rate note on which it must pay yearly interest of 1-year LIBOR+2% (1-year LIBOR currently yields 3.70%, therefore, the floating rate note's first interest payment of $5.7 million would be paid at the end of year 1). However, General Motors wants to have a fixed rate liability for the entire 3 years. Assuming the following instruments are also available to General Motors (with City Bank, an AAA rate bank as the counter party), which strategy will enable General Motors to pay the lowest all-in-fixed rate of interest (assume all rates are quoted on an annual basis?

Swap	3-year swap has all-in pay-fixed rate of 3 year Treasury + 30 basis points (=4.50 %+0.30) versus receiving 1 year LIBOR.
FRAs	12/24 FRA has all-in pay-fixed rate of 2-year Treasury+90 basis points (=4.10%+0.90%) versus receiving 1-year LIBOR.
	24/36 FRA has all-in pay-fixed rate of 3 year Treasury+150 basis points (=4.50 %+1.50%) versus receiving 1-year LIBOR.

Caps	Premium for 3-year caps (with annual pay) on 1-year LIBOR
Strike Rate	Premium
4.00%	2.23%
4.80%	0.70% 3.5%
5.00%	0.49%
6.00%	0.08%

Premium for 3-year caps (with annual pay) on 1-year LIBOR

Floors	
Strike Rate	Premium
4.00%	0.18%
4.80%	0.70%
5.00%	0.90%
6.00%	3.22%

*Assume that FRAs are settled at the end of the period

INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR
End-Autumn Semester Examination 2022-23

Date of Examination: 18-11-2022____Session: (FN/AN): __AN__ Duration: 3 hrs.__ Full Marks: 50

Subject No.: HS50024_____Subject: ECONOMICS OF CLIMATE CHANGE_____

Department/Center/School: DEPARTMENT OF HUMANITIES AND SOCIAL SCIENCES_____

Specific charts, graph paper, log book etc., required   NOT REQUIRED_____

Special Instructions (if any):   Use of scientific calculator is permitted_____

Part A: ($4 \times 10 = 40$ Marks)
Answer ALL Questions

1. Discuss the key ethical issues associated with the climate change problem.   (**10 Marks**)

2. Discuss in detail the Ricardian approach to assess the economic impact of climate change on the agriculture sector. What is the rationale behind the naming of this approach? Discuss its key limitations.

(**5+2+3 Marks**)

3. What are RCPs? What do they convey? Discuss their importance in the climate change context. In this aspect, what is the difference in the approach taken by AR5 and AR6?

(**2+2+4+2 Marks**)

4. Consider the following equation   (**2+2+3+3 Marks**)

$$y_{it} = \beta C_{it} + \gamma Z_{it} + \mu_i + \theta_{rt} + \varepsilon_{it}$$

where y_{it} is the outcome variable of interest, C_{it} is the vector of weather variables, and Z_{it} is the vector of time varying observables.

(a) What do the i and the t subscripts capture? Interpret the vectors β and γ.

(b) Interpret the two terms μ_i and θ_{rt} in the equation. What role do they play in the equation?

(c) Can C_{it} include any climate variables? Specify further the above equation and discuss how one can bring non-linear effects into the assessment such equations facilitate.

(d) In the context of such non-linear equation, identify how to assess the climate change impacts.

[P.T.O.]

1

Part B: (5 × 2 = 10 Marks)
Answer ALL Questions

5. Name the GHG that has the highest global warming potential.

6. Name one global convention that has been successfully implemented.

7. What does IPCC stand for?

8. What does UNFCCC stand for?

9. Discuss the implications of rising CO_2 emissions but decreasing emission intensity in the context of climate change mitigation.

INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR
End-Autumn Semester 2022-23

Date of examination: 16.11.2022   Session (FN / AN): AN   Duration: 3 hours   Full marks: 80
Subject No.: AI61005   Subject: Artificial Intelligence: Foundations and Applications
Department/Center/School: Centre of Excellence in Artificial Intelligence (CoEAI)
Instructions: Answer all questions. All parts of a question must be answered in the same place.

PART-A (Four Questions)

A1. Consider the crossword puzzle and the corresponding word list below:

1		2		3
	4		5	
6		7		
8				

Word List		
AFT	HOSES	LINE
ALE	KEEL	SAILS
EEL	KNOT	SHEET
HEEL	LASER	STEER
HIKE	LEE	TIE

The numbers 1,2,3,4,5,6,7,8 in the crossword puzzle correspond to the words that will start at those locations.

a) Let the variables be 1A, 2D, 3D, 4A, 5D, 6D, 7A, 8A where the digits signify the locations marked in the cells; A (ACROSS) and D(DOWN) signify the horizontal and vertical direction respectively. Represent the given crossword problem as a Constraint Satisfaction Problem clearly mentioning the domains of each variable and the constraints.

b) Draw the corresponding constraint graph clearly labeling the nodes and edges.

c) Show the trace of the backtracking search (in tree form) until the first backtracking decision is made. Follow the variable order 1A, 2D, 3D, 4A, 7A, 5D, 8A, 6D.

d) Show one step of AC-3 algorithm in the following format.

$X_i \rightarrow X_j$	Revised domain of D_i of X_i	New edge added in queue

[2+1+2+5 = 10 marks]

A2. Answer the following questions related to Constraint Satisfaction Problems (CSP).

a) Consider two CSP formulations of the N-queen problem. In Formulation 1, each cell is a variable and the domain of each variable is {0,1}. In Formulation 2, we consider each row as a variable and the values are the column indices {1,2,...,N}. Compare Formulation 1 and 2 in terms of the size and branching factor of their state space and depth of the search tree.

b) Show how any n-ary CSP can be converted into a binary CSP containing only binary constraints. Take a ternary constraint to illustrate.

c) Solve a 5-queen problem using *iterative improvement algorithm*. Show the relevant steps.

[2+3+5 = 10 marks]

A3. Answer the following questions related to propositional satisfiability:

a) Represent a 4-queen problem as a propositional satisfiability problem.

b) Use DPLL algorithm to check the satisfiability of the following CNF knowledge base:

$$\{(p \lor q \lor r \lor s), (\neg p \lor q \lor \neg r), (\neg q \lor \neg r \lor s), (p \lor \neg q \lor r \lor s), (q \lor \neg r \lor \neg s),$$
$$(\neg p \lor \neg r \lor s), (\neg p \lor \neg s), (p \lor \neg q)\}$$

c) Convert the following SAT problem into a CSP clearly mentioning variables, domains and constraints. ∩ draw the constraint graph.

$$(y \lor z) \land (x \lor \neg y \lor z) \land (x \lor \neg z) \land (x \lor \neg y \lor \neg z)$$

[3+3+(2+2)=10 Marks]

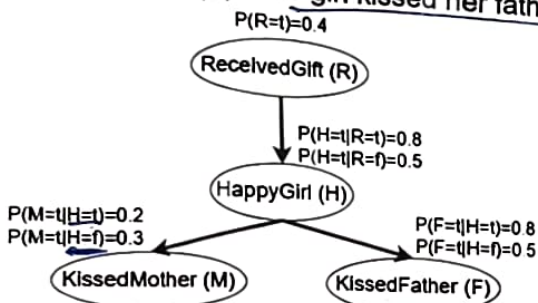**A4.** Answer the following questions related Bayesian Belief Network:
a) Consider the following Bayesian Belief Network involving random variables all with binary domains.
ReceivedGift (R): A girl received a gift or not
HappyGirl (H): The girl is happy or not
KissedMother (M): The girl kissed her mother or not
KissedFather (F): The girl kissed her father or not

P(R=t)=0.4

ReceivedGift (R)

P(H=t|R=t)=0.8
P(H=t|R=f)=0.5

HappyGirl (H)

P(M=t|H=t)=0.2
P(M=t|H=f)=0.3

P(F=t|H=t)=0.8
P(F=t|H=f)=0.5

KissedMother (M)   KissedFather (F)

Calculate the probability that the girl is happy provided she did not kiss her mother (i.e., P(H=t|M=f)). Also calculate the probability that the girl received the gift provided she is happy and did not kiss her mother (i.e., P(R=t|H=t,M=f)).

b) Consider the following Bayesian Belief Network. Infer different d-separation sets for the specifications given below. Justify your answers with explanations.
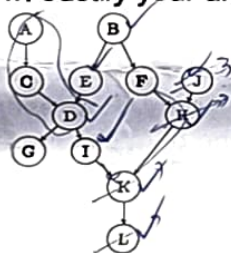
I. Find set of variables that are d-separated from F given E.

II. Find set of all variables that are d-separated from F given E and K.

F I

[(3+2)+(2+3)=10 Marks]

PART – B (Five Questions)

B1. Use the dataset below to learn a Decision Tree which predicts the grade obtained in the AI course by a student.

Attendance	Studied	CGPA	Grade
L	T	L	A
L	F	H	A
L	T	L	A
H	T	H	C
H	T	L	C
H	F	L	C
H	F	H	C
L	F	L	C

It may be helpful to note that $\log_2 3 \approx 1.6$, $\log_2 5 \approx 2.3$, $\log_2 7 \approx 2.8$

a) What is the entropy of the root state (Grade)?
b) There are 3 possible attributes for the Root node. Find the *information gain* for each attribute and suggest the attribute to be used at the root node.

[6 marks]

2

2. Suppose that you want to train a hypothesis of the form
$$h(x) = w_0 + w_1 x + w_2 \cos x$$

a) Find update rules for w_0, w_1 and w_2 assuming you do gradient descent using MSE (Mean square error) as the error function. Assume that there are m training examples.

b) True or False? If true, explain why in at most two sentences. If false, explain why or give a brief counterexample in at most two sentences.

"If you are given m data points, and use half for training and half for testing, the difference between training error and test error decreases as m increases."

[6+2=8 marks]

**B3.** Answer the following questions in brief.

a) What is syntax? (1 sentence)

b) What is semantics? (1 sentence)

c) Sketch any one word2vec model that can be used to learn word representations. How many parameters are there in your model? State any assumption you make.

[2+2+4=8 marks]

B4. Consider a 4-state MDP as given in the figure below. In state $s4$ there is just one action, **Stay**, that fetches a reward of $+10$. In all the other states there are two actions:

- **Right**, which moves one step to the right with probability 0.9 and stays put with probability 0.1.
- **Home**, which deterministically goes back to state $s1$.

There is a reward of $+1$ for Right and 0 for Home. The discount factor is $\gamma = 0.8$
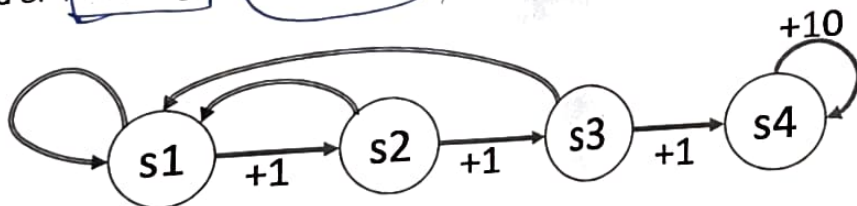
a) What is the optimal policy?

b) What is $V^*(s4)$, that is, the optimal value of state $s4$?

c) What is $V^*(s3)$?

d) Suppose you are doing *value iteration* to figure out these values. You start with all value estimates equal to 0. Show the V values of each state after 1 and 2 iterations respectively by filling up the table below.

	V(S1)	V(S2)	V(S3)	V(S4)
	0	0	0	0
t=0				
After Iteration 1				
After Iteration 2				

[6 marks]

3

B5. Consider the following domain with two rooms, R1 and R2 and a cleaner robot Safa. Safa can be at R1 or R2, which can be represented by the propositions At(R1) and At(R2) respectively. Each room can be clean or dirty. Clean(x) represents that Room x is clean. Safa has three actions: Left and Right for moving between the rooms and Mop(x) for cleaning the Room where it is in.

Right:
  Precond: At(R1)
  Effect: At(R2) ∧ ¬At(R1)

Left:
  Precond: At(R2)
  Effect: At(R1) ∧ ¬At(R2)

Mop(x)
  Precond: At(x)
  Effect: Clean(x)

The initial state is At(R1), and goal condition is Clean(R2).

Give a description of this planning problem in terms of propositional formulas, suitable as an input to the SATPLAN algorithm when searching for a plan of length two (consisting of exactly 2 actions).

[12 marks]

INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR
End-Autumn Semester 2022-23

Date of Examination: _____   Session (FN/AN): __ Duration: 3 hrs Full Marks: 50
Subject No.: HS50001   Subject: ADVANCED ECONOMIC THEORY
Department/Center/School: HUMANITIES & SOCIAL SCIENCES
Specific charts, graph paper, log book etc., required: None
Special Instructions (if any): None

Section I (answer all)

1. What are the different types of auction rules? Explain how can we design a private-value auction such that the bidders reveal their true valuations? What would be the best auction rule (or rules) that the seller might choose if it is a common-value auction?   (4+5+4)

2. Asterix and Obelix are bargaining to split a total that starts out at $100. Asterix makes the first offer, stating how the $100 will be divided between them. If Obelix accepts this offer, the game is over. If Obelix rejects it, a dollar is withdrawn from the total, so it is now only $99. Then Obelix gets the second turn to make an offer of a division. The turns alternate in this way, a dollar being removed from the total after each rejection. Asterix's BATNA (best alternative to a negotiated agreement) is $2.25 and Obelix's BATNA is $3.50. What will be the equilibrium outcome of the game?   (7)

3. There are two OPEC countries — Saudi Arabia (SA) and Venezuela (VA). Each of these producers can produce either a high output or a low output. But they differ in their production capacity. SA can produce either 10 units or 8 units while VA can produce either 7 units or 5 units. Price of oil is highest when both choose to produce low outputs and price of oil is lowest when both choose to produce high outputs. On the demand side, let us suppose that demand conditions can be either good or bad. When conditions are good (when demand is robust) a total output of 13 fetches a price of $25 per barrel, whereas the price is only $22 per barrel for an aggregate output of 15 and $19 for the highest output level. When times are bad (demand is weak), the three prices are respectively $16, $15, and $14 per barrel for high, medium, and low total output. Cost of production is constant at $5 per barrel for both the countries.

    i)   Draw the pay-off matrices for the countries under different demand scenarios.   (2+2)
    ii) Find out the value(s) of δ (SA's discount factor) for which SA will cooperate in good times provided grim strategy.   (2)
    iii) Find out the value(s) of ρ (VA's discount factor) for which VA will cooperate in good times provided grim strategy   (2)
    iv) Find out the value(s) of ρ (VA's discount factor) for which VA will cooperate in bad times provided grim strategy   (2)

Section II (answer any four)

4. A group has 100 members. Each person can choose to participate or not participate in a common project. If n of them participate in the project, then each participant derives the benefit equal to the number of participants and each of the shirkers derives the benefit $s(n) = (4 + 3n)$. What will be the Nash equilibrium number of participants? What would be the number of participants that maximizes the total benefit of the group? What type of game is this?   (2+2+1)

There are two types of cars in the second-hand car market of the US – bad condition cars (lemons) and good condition cars (peaches). The seller of a car knows the exact condition of the car (good or bad) but the potential buyer can't observe that. The potential buyer only knows that there are twice as many lemons as peaches in the market. The reservation prices (in US$) for the buyer and the sellers are given as –

	Buyer	Seller
Peaches	3000	2500
Lemons	2000	1000

$2(P) = L$

What will be the equilibrium price (or equilibria prices) that will clear the above mentioned second-hand car market in the US? (5)

6. Kishore has a risky income of Rs. 1,60,000 with good luck and Rs. 40,000 with bad luck. Rafi has a sure income of Rs. 1,00,000. Let the probability of Kishore's good luck be 0.6. They derive a scheme in which they can eliminate all of Kishore's risk while raising Rafi's expected utility slightly. Assume that the utility is given by the square root of the respective income. Consider a contract that leaves Kishore with exactly Rs. 1,00,000 when he has bad luck. Let z be the payment that Kishore makes to Rafi when he has good luck.

i) What is the minimum value of z (to the nearest rupee) such that Rafi prefers to enter into this kind of contract rather than no contract at all? (2.5)

ii) What is the maximum value of z (to the nearest rupee) for which this kind of contract gives Kishore a slightly higher expected utility than no contract at all? (2.5)

7. What is "tragedy of commons"? How can we eradicate the "tragedy"? Explain. (5)

8. Discuss the concept of "revenue equivalence" in auctions. (5)

9. Discuss, with example, the concept of variable threat bargaining. (5)