Note: All questions are compulsory. Marks are indicated against each question in square brackets.

Q1. Indian Olympic Association wants to design a database for storing the information of Indian athletes and their participations in Olympic Games.
- An athlete has his/her Aadhar card, the name, and the birth date.
- Each Olympiad has the year, the country, and the city. For example, the 2012 Olympic game was held in London, UK.
- An athlete can participate in several sports in an Olympiad. For example, Michael Armstrong participated in the swimming, diving, and water polo events.
- Every athlete in our database participated in at least one Olympiad. Every Olympiad has at least one athlete (and actually, several thousands).

Answer the following: **[CO1] [4]**
a) Draw an ER diagram for this database. Make sure to indicate primary keys, cardinality constraints, weak entities (if any), and participation constraints.

Q2. Consider the relation schema R(A, B, C, D, E, G) with functional dependencies F = {AB->C, AG->E, B->D, E->G}. Notice F is the minimum cover of itself. Consider the following decompositions:
- {ABC, CDE, EG}
- {ABCD, AEG}
- {ABCE, BD, AEG}

For each of the above decompositions of R (A, B, C, D, E, G), determine whether it is (a) dependency-preserving, and (b) lossless. Justify your answer with reason.   **[CO3] [5]**

Q3. Consider the relation schema R(A, B, C, D) with functional dependencies A->D, B->CD and AC->D. Answer the following: **[CO4] [6]**
a) Find the value of $\{A\}^+$, $\{A,B\}^+$.
b) Find the canonical cover.
c) Find all the candidate keys of R.

Q4. Consider the following two schedules of actions on the data items A, B, C and D, listed in the order it is submitted to the DBMS (S is a shared lock, X is an exclusive lock): **[CO5] [3+3]**
S1: T4:X(A), T3:S(C), T1:S(B), T2:X(B), T3:X(C), T2:X(A), T1:S(C), T4:S(B)
S2: T1:X(A), T3:S(D), T3: S(A), T4:X(C), T2:S(B), T4:X(A), T2:X(C), T1:X(B), T4:X(D)

For both the sequences S1 and S2, **answer the following:**
a) Mention for each request whether the request is granted or blocked by the lock manager.
b) Show the waits-for graph and indicate whether there will be a deadlock or not at the end of each sequence.

Q5.Consider the following schedules. The actions are listed in the order they are scheduled, and prefixed with the transaction name. **[CO6] [2+2+2]**
S1: T2:R(B), T2:W(B), T1:W(A), T1:R(B), T3:R(A), T1:W(B), T2:W(A)
S2: T1:R(B), T3:R(A), T3:W(A), T2:R(B), T2:W(A), T3:W(C), T1:R(A), T2:R(C)
Answer the following:
a) Which schedule is serial S1, S2 or both? Why?
b) Draw the dependency graph for S1 and S2.
c) Find the conflict serializability of both the schedules? Obtain the conflict equivalent serial schedule?

Q6. Consider the following schedule on the database objects A, B, and C. The meanings of the operations are as follows. **[CO7]**
- R(object): read the object
- W(object) write the object

Time	T1	T2	T3
1			
2			R(C)
3			
4			
5			
6	R(A)		
7			
8			
9			
10			W(C)
11		R(A)	
12		W(A)	
13			
14			
15			
16	W(B)		

Time	T1	T2	T3
17			
18			
19			
20	R(D)		
21			
22			
23		Commit	
24			
25			
26			
27	Commit		
28			
29			
30			
31			W(B)
32			
33			Commit

Answer the following:
a) Is the schedule allowed by 2PL? If the answer is NO, explain the reason briefly. If YES, describe where the lock/unlock requests could have happened. **[4]**
b) Is the schedule allowed by strict 2PL? If the answer is NO, explain the reason briefly. If YES, describe where the lock/unlock requests could have happened. **[4]**