Part II: Attempt all questions [70 pts].

1. Consider the following statistics on relations and attributes to answer the following questions.

R (A, B, C)	S (C, D)	U (D, E)
T(R) = 1000	T(S) = 200	T(U) = 5000
V(R, A) = V(R, B) = V(R, C) = 20	V(S, C) = 50	V(U, D) = V(U, E) = 500
A : 20 bytes string	V(S, D) = 100	
B : 4 bytes integer		
C : 8 bytes date		
D : 5 bytes string		
E : 4 bytes integer		

Estimate the result sizes (in bytes) of the queries (Q1 to Q5) below: [show formulas in your computations]

    a. Q1 = $\pi_{A, B}$ (R) [5 pts]

    b. Q2 = $\sigma_{B \neq 10}$ (R) **[5 pts]**

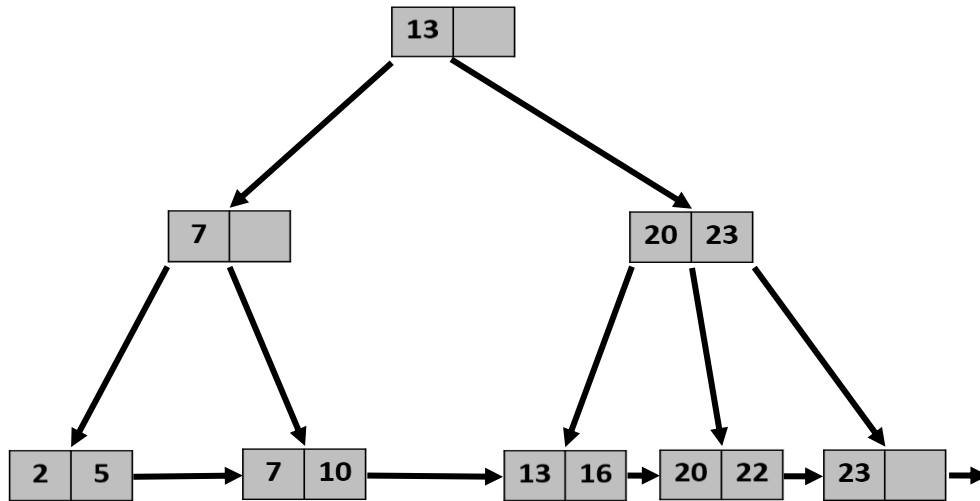c. $Q3 = \sigma_{D \neq "male" \lor C > 01/01/2024} (S)$ **[5 pts]**

d. $Q4 = S \times U$ **[5 pts]**

e. $Q5 = R \bowtie S \bowtie U$ **[5 pts]**

2. Suppose each B+-tree node can hold up to two (2) keys. Draw the B+-trees that would result after insertion (a) and deletion (b) operations as shown below.

(a)   Insertion [5 pts]

First, insert **19**. Then, insert **12** [Show individual trees at each insertion].

(b) **Deletion: Use the tree after inserting 12 in part (a)**

First, delete **23**; then delete **16**; next, delete **7**; after that, delete **12**; and finally, delete **20**
[15 pts] [Show individual trees at each deletion].

[cont'd: Show individual trees at each deletion].

3. Consider the following schedules **(S1 and S2)** with two transactions **T1** and **T2** as shown below.

Schedule 1 (S1)

Instructions	T1	T2
1	Read(A);	
2	A:= A - 10;	
3	Write(A);	
4		Read (A);
5		temp:=A*0.5;
6		A:= A – temp;
7		Write (A);
8	Read(B)	
9	B:=B+10;	
10	Write(B);	
11		Read(B)
12		B:= B + temp;
13		Write(B);

Schedule 2 (S2)

Instructions	T1	T2
1		Read (A);
2		temp:=A*0.5;
3		A:= A – temp;
4		Write (A);
5		Read(B)
6		B:= B + temp;
7		Write(B);
8	Read(A);	
9	A:= A - 10;	
10	Write(A);	
11	read(B)	
12	B:=B+10;	
13	Write(B);	

a. Are S1 and S2 serializable schedules? Please explain along with any form of evidence or proof. *Assume an initial value: A = 50, B = 50* **[10 pts]**

4. Check whether schedule S is conflict serializable or not. If S is conflict serializable, give all possible schedules equivalent to Schedule S **[15 pts]**

Schedule S: R1(A), W2(A), R3(A), R1(B), R4(C), W2(B), R1(D), W3(D), R4(D), W4(B), W5(B), W5(C)

Good luck