Question 1

1. RPC is synchronous while ZeroMQ is asynchronous [No marks for no other difference as any other difference is not a *primary* difference.]
2. Parameter marshaling is done to convert the request data into machine-independent format whereas unmarshalling is done to convert it back to the machine-dependent format.
3. Steps: [0.5 marks for each step]

(a) client sends the request to the coordinator for acquiring a shared resource.

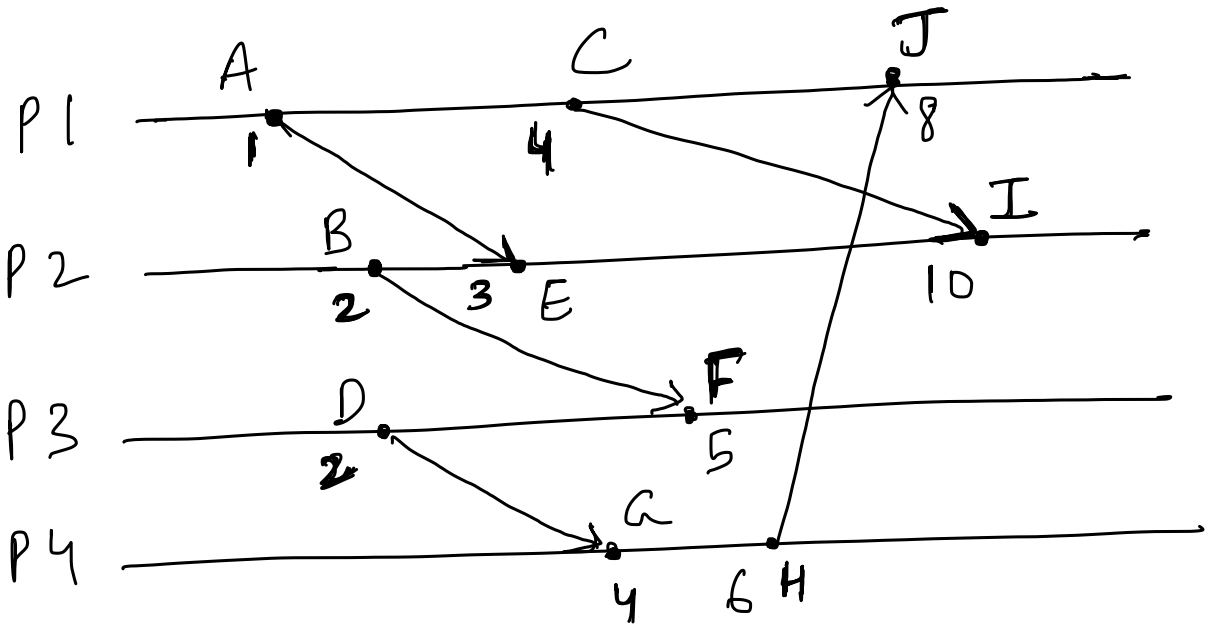
(b) Coordinator grants the request if the resource is not currently used by any other process.

(c) If the resource is currently used by any other process, it simply queues the request.

(d) Whenever a process is done using the resource, it sends a release message to the coordinator. The coordinator then allows the first waiting process in its queue to use the resource.

4. The process with the largest process id is elected as the leader in the bully algorithm.

Question 2



A : V(A) = [1, 0, 0, 0]

B : V(B) = [0, 1, 0, 0]

C : V(C) = [2, 0, 0, 0]

D : V(D) = [0, 0, 1, 0]

E : V(E) = [1, 2, 0, 0]

F : V(F) = [0, 1, 2, 0]

G : V(G) = [0, 0, 1, 1]

H : V(H) = [0, 0, 1, 2]

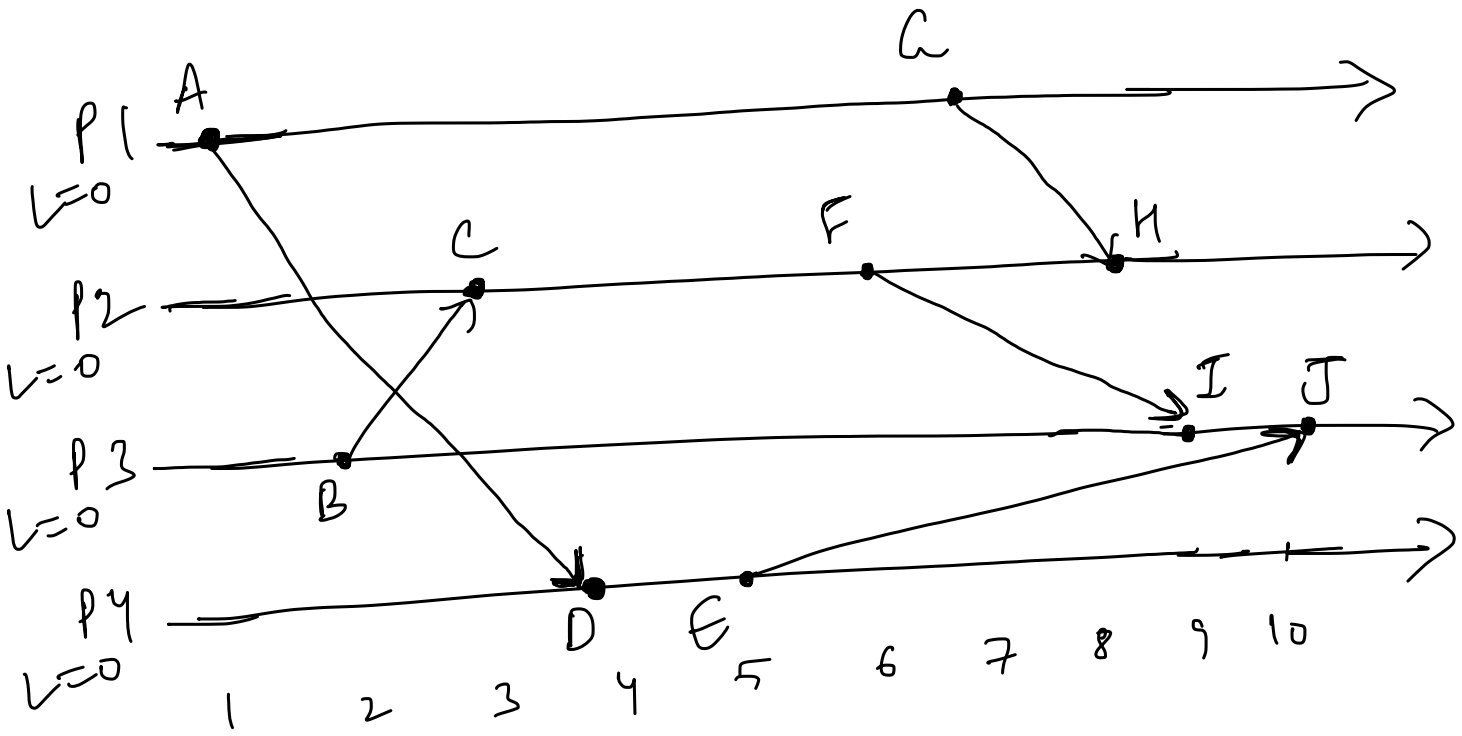
I : V(I) = [2, 3, 0, 0]

J : V(J) = [3, 0, 1, 2]

Rubric :- 1 mark for each correct event

No partial marks

Question 3



A ⇒ L=1

B ⇒ L=1

C ⇒ L=2

D ⇒ L=2

E ⇒ L=3

F ⇒ L=3

G ⇒ L=2

H ⇒ L=4

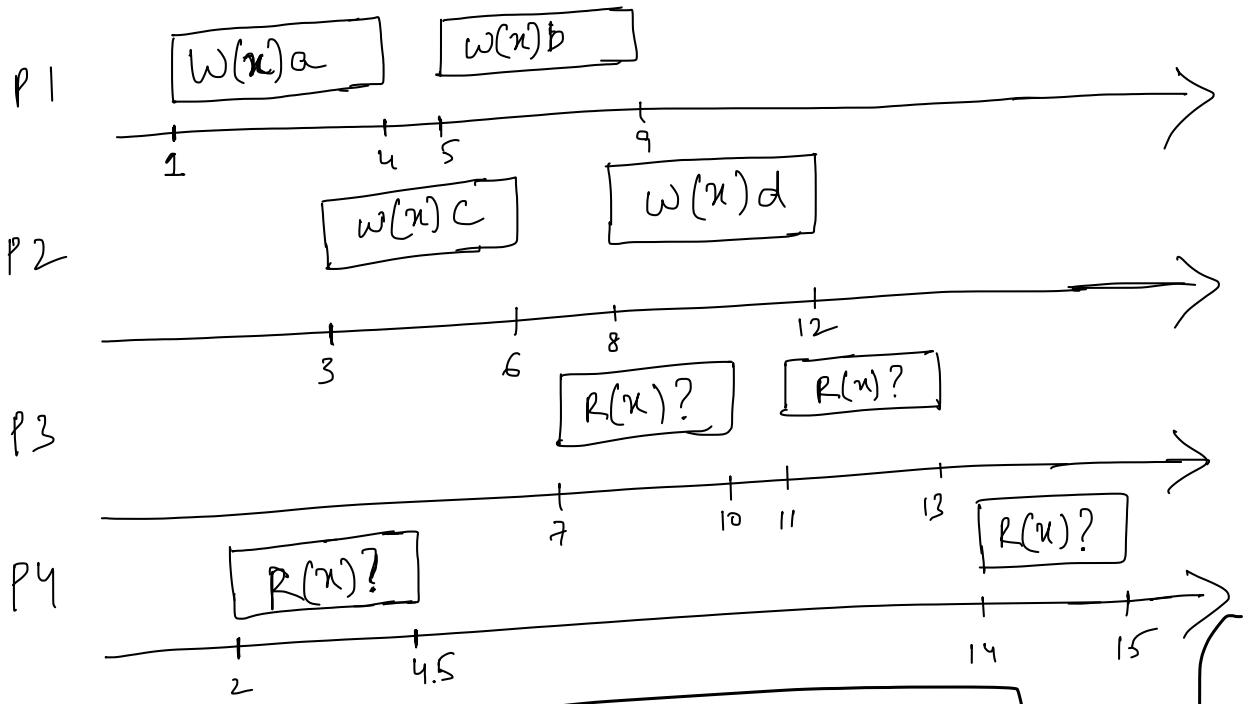
I ⇒ L=4

J ⇒ L=5

Rubric :- 1 mark for each correct event

No partial marks

Question 4



Many possible answers

Rubric for each part [(a),(b),(c),(d),(e)] :-

⇒ 2 marks if all reads have correct value

⇒ 1 mark if both reads of a particular process (P_3 or P_4) are correct

⇒ 0 marks otherwise.

↳ only for (a) and (b)

No partial marking for (c), (d), (e)

(a) $R_3(x)\ [7,10] = b$ $R_3(x)\ [11,13] = d$

$R_4(x)\ [2,4.5] = a$ $R_4(x)\ [14,15] = d$

⇒ Only one possibility for strict consistency

(b) $R_3(x)\ [7,10] = c$ $R_3(x)\ [11,13] = b$

$R_4(x)\ [2,4.5] = NIL$ $R_4(x)\ [14,15] = d$

⇒ only one possibility for linearizability

(c) $R_3(x)\ [7,10] = a$ $R_3(x)\ [11,13] = b$

$R_4(x)\ [2,4.5] = a$ $R_4(x)\ [14,15] = b$

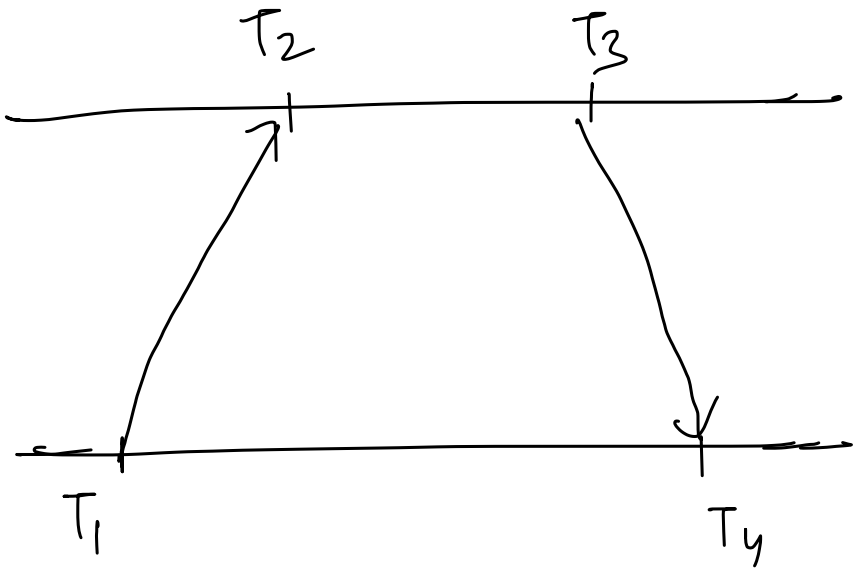
(d) $R_3(x)\ [7,10] = c$ $R_3(x)\ [11,13] = a$

$R_4(x)\ [2,4.5] = a$ $R_4(x)\ [14,15] = c$

(e) $R_3(x)\ [7,10] = b$ $R_3(x)\ [11,13] = a$

$R_4(x)\ [2,4.5] = a$ $R_4(x)\ [14,15] = b$

Question 5



Round trip delay $(RTT) = (T_4 - T_1) - (T_3 - T_2)$ — (1 marks)

$D_{c-s} + D_{s-c} = RTT$

$0.5\, D_{s-c} + D_{s-c} = RTT$

$D_{s-c} = \frac{2}{3} RTT$

$D_{c-s} = \frac{1}{3} RTT$ — 2 marks

2 marks

$$\text{offset} = T_3 + D_{s-c} - T_4$$

$$= T_3 + \frac{2}{3}\left[T_4 - T_1 - T_3 + T_2\right] - T_4$$

$$\text{offset} = \frac{T_3 - T_4 - 2T_1 + 2T_2}{3}$$