ALGORITHMS TEST 2

Number of Questions: 35 **Section Marks: 30**

Directions for questions 1 to 35: Select the correct alternative from the given choices.

1. What is the worst case time complexity of search operation on unordered and ordered List, using Linear search Algorithm respectively?
(A) $O(n)$ and $O(1)$
(B) $O(n)$ and $O(\log n)$
(C) $O(n)$ and $O(n)$
(D) $O(\log n)$ and $O(\log n)$

2. Which of the following is the Recurrence relation for binary search and What is the time complexity of that Recurrence Relation respectively?
(A) $T(n) = T(n/2) + \theta(n)$ and $\theta(\log n)$
(B) $T(n) = T(n/2) + \theta(1)$ and $\theta(\log n)$
(C) $T(n) = T(n/2) + \theta(1)$ and $\theta(n \log n)$
(D) $T(n) = T(n/2) + \theta(n)$ and $\theta(n \log n)$

3. Given 'n' numbers randomly, what is the time complexity of calculating median?
(A) $O(\log n)$ (B) $O(n \log n)$
(C) $O(n^2)$ (D) $O(n^2 \log n)$

4. Given an array of 'n' elements, what is the time complexity of Finding a number which appears more than $(n/2)$ times in the given array (if it exists)?
(A) $O(n/2)$ (B) $O(n \log n)$
(C) $O(\log n)$ (D) $O(n^2)$

5. What is the number of comparisons performed to find the smallest and largest keys in an array A of even size and odd size of n and $(n + 1)$ elements respectively?
(A) $\frac{3n}{2} - 2$ and $\frac{3n}{2}$ (B) $\frac{3n}{2}$ and $\frac{3n}{2} - 2$
(C) $\frac{3n}{2} - 2$ and $\frac{3n}{2} - \frac{3}{2}$ (D) $\frac{3n}{2} - 2$ and $\frac{3n}{2} + 1$

6. What is the time complexity of an algorithm, for finding Fourth Largest element in the given input list of n elements?
(A) $2n - 3$ (B) $2n - 4$
(C) $2n - 5$ (D) $2(2n - 5)$

7. The Bellman-Ford algorithm solves the single-source shortest path problem in the case in which edge weights may be negative, what is the time complexity of running Bellman-Ford Algorithm?
(A) $O(V^2)$ (B) $O(V * E)$
(C) $O(V + E)$ (D) $O(E \log V)$

8. Construct a Hash table with size '8', hash function is $h(k) = (2k + 1) \bmod 8$, with elements 3, 8, 16, 9, 1, 4. What is the Location of key '4'?
(A) Location 1 (B) Location 2
(C) Location 4 (D) Location 5

9. Consider the given two strings str1 and str2.
Let str1 = < A B R A C A D A B R O A >
str2 = < Y A B B A D A B B A D O O B A >
Then the length of longest common subsequence would be _____.

10. Which of the following is the regular expression to the string of the form $a^m b^{2n} c^{3p}$, where $m, n, p \geq 2$.
(A) $a^* b^* c^*$
(B) $aa^* (bb)(bb)^* ccc(ccc)^*$
(C) $aaa^* (bbbb)(bb)^* cccccc(ccc)^*$
(D) $aa(aa)^* (bbbb)(bbbb)^* cccccc (cccccc)^*$

11. Which of the following statements are TRUE.
(i) $3n + 1 \in O(3^n)$
(ii) $100n \log n \in O(n \log n)$
(iii) $2n \neq O(n^k)$; K is a constant.
(iv) $0 < i < j$; $n^j \in O(n^i)$
(A) (i, ii, iii) (B) (i, ii, iv)
(C) (ii, iii) (D) (i, ii)

12. Suppose that we want to encode strings over the 8-character alphabet $C = \{a, b, c, d, e, f, g, h\}$ by using Fixed Length Encoding, and the frequencies are given below:
a – 11, b – 13, c – 12, d – 10, e – 9, f – 7, g – 5, h – 3
The number of bits required to store string '*abfeg*' is _____.

13. In Depth First search Algorithm, _____ number of times all the vertices are accessed, in a graph $G(V, E)$:
(A) one (B) two
(C) three (D) four

14. What is the number of substrings of any length excluding empty string, of a given string of length 'n', that can be formed?
(A) n^2 (B) $n \log n$
(C) $\frac{n(n+1)}{2}$ (D) $\frac{n(n-1)}{2}$

15. What is the time complexity of running Bellman-Ford Algorithm on K-Regular graph $(K \geq 3)$?
(A) $O(n^2 \log n)$
(B) $O(n^3)$
(C) $O(2^n)$
(D) $O(n \log n)$

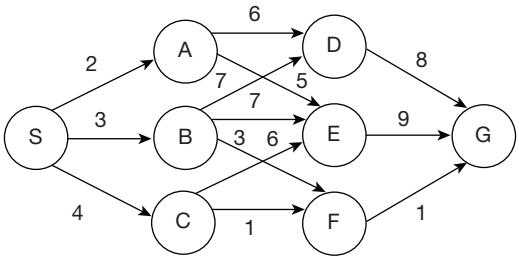
16. Consider the given array

4	2	6	4	2	6

For finding the first element in the array which is repeated, which of the following is TRUE?
(A) Sort the given array, in this sorted array, the first element is the repeated element.
(B) Use brute force method, every element is checked with all the other elements, return the first element which is repeated.

(C) Sort the given array in descending order, in this sorted array the first element is the repeated element.
(D) Both (A) and (B)

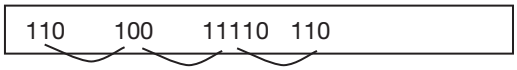
17. Consider the given multi stage graph



What is the shortest path from node '*S*' to node '*G*' using Greedy Approach?
(A) 16 (B) 6
(C) 7 (D) 19

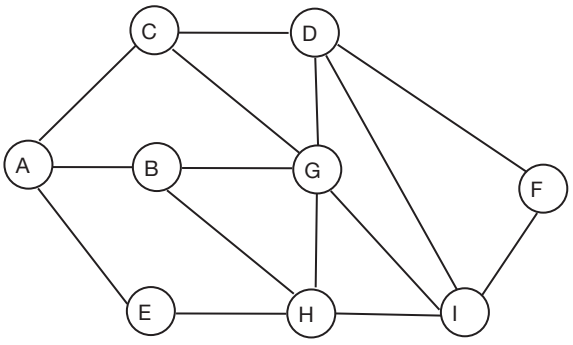
18. Consider the same graph given in the above question, What is the shortest path from node '*S*' to node '*G*' using Dynamic programming?
(A) 6 (B) 7
(C) 16 (D) 19

19. Consider the given Huffman code:



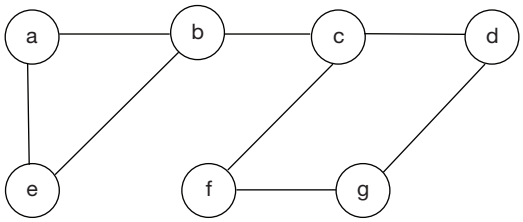
Huffman code is constructed for the following set of letters whose frequencies are based on the first 8 Fibonacci numbers?
$a-1, b-1, c-2, d-3, e-5, f-8, g-13, h-21$
Which of the following sequence of letters correctly matches the given Huffman code?
(A) *f g h a d* (B) *f g h c e*
(C) *f g h d f* (D) *f g h d e*

20. Implement Breadth-First search on the graph given below, starting at vertex *A*. Assume that the adjacency lists are in sorted order. Example when exploring vertex *E*, the algorithm considers the edge *E* – *B*, before *E* – *C*, *E* – *F*, *E* – *G*, or *E* – *H*. Which of the following is the order of vertices that are enqueued on the FIFO queue?



(A) A, B, C, E, G, H, I, D, F
(B) A, B, C, E, H, G, D, I, F
(C) A, B, C, D, E, G, H, I, F
(D) A, B, C, E, G, H, D, I, F

21. Consider the given graph



Implement Depth First search Algorithm on the given graph, which of the following cannot be the sequence of poped elements?
(A) *a, b, c, d,* g, *f, e* (B) *c, d, g, f, b, a, e*
(C) *c, d, g, f, b, e, a* (D) *f, g, d, c, a, e, b*

22. Consider the graph given in the above Question, Implement Breadth First search on the given graph, Which of the following cannot be the sequence of nodes Dequeued?
(A) *d, c, g, f, b, a, e* (B) *g, f, d, c, b, a, e*
(C) *f, c, g, b, d, a, e* (D) *e, a, c, d, g, f, b*

23. The keys 22, 31, 46, 42, 58, 61, 64, 71, 83, 97 are inserted into an initially empty hash table of length 10 using open addressing with hash function $h(k) = k$ mod 10 and Linear probing. What is the Resultant hash table?

(A)

0	1	2	3	4	5	6	7	8	9
83	31	22	42	61	64	46	71	58	97

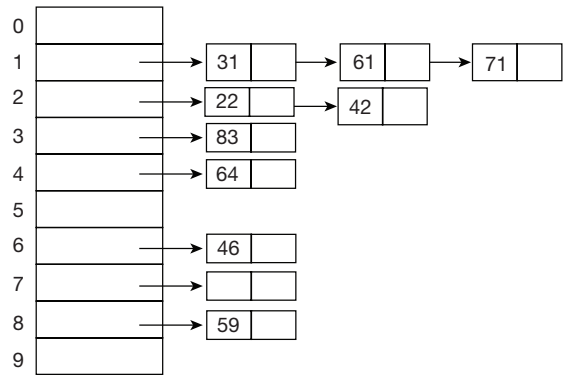
(B)

0	1	2	3	4	5	6	7	8	9
97	31	22	42	61	64	46	71	58	83

(C)

0	1	2	3	4	5	6	7	8	9
	31 61 71	22 42	83	64		46	97	58	

(D)



24. What is the number of bits required to store a file of 200 characters, The frequencies of a, b, c, d are as follows a – 25, b – 50, c – 100, d – 25 using Fixed Length Encoding?
(A) 200 bits (B) 800 bits
(C) 400 bits (D) 600 bits

25. Consider the data given in the above question what is the number of bits required to store the file using variable Length Encoding scheme?
(A) 200 bits (B) 250 bits
(C) 300 bits (D) 350 bits

26. Consider the tasks T_1, T_2, T_3, T_4, T_5. Following table shows, Deadlines and profits of the given tasks

Task	Deadline	Profit
T_1	2	20
T_2	2	50
T_3	1	30
T_4	1	40
T_5	4	60

Which tasks are not executed?
(A) T_1 and T_2 (B) T_1 and T_5
(C) T_1 and T_3 (D) T_2 and T_5

27. For the data given in the above question, what is the profit made from the tasks executed?
(A) 150 (B) 90
(C) 120 (D) 130

Common Data for questions 28 and 29:

```
Consider the given code:
int fun (int k[ ], int n)
{
int counter = 0, max = 0;
for (int i = 0; i<n; i ++)
{
counter = 0;
for (int j = 0; j <n; j++)
{
if (k[i] = = k[j])
counter ++;
}
if (counter >max)
max = counter;
}
return max;
}
```

28. What is the task performed by the given code?
(A) Counting the number of swaps.
(B) Finding the element which appears maximum number of times in the array.
(C) Finding the element which appears minimum number of times in the array.
(D) Counting the number of comparisons.

29. What is the time complexity in executing the given code?
(A) $O(\log n)$ (B) $O(n \log n)$
(C) $O(n^2)$ (D) $O\left(n\sqrt{n}\right)$

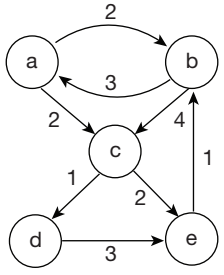
Common Data for Questions 30 and 31:
Consider the following code:

```
void fun1(int k[ ], int n, int X)
{
for (int i = 0; i < n; i++)
{
for (j = i; j < n; j++)
{
if (k[i] + k[j] = = X)
{
printf("Items found")
return;
}
}
}
printf("Items Not found");
}
```

30. The above code performs
(A) The sum of 2 array elements is equal to given 'X' value.
(B) Sum of adjacent elements whose sum is equal to given 'X' value.
(C) The sum of adjacent elements if they are equal.
(D) The sum of adjacent elements which are equal and equal to given 'X' value.

31. What is the time complexity of given code?
(A) $O(n \log n)$
(B) $O(n^2)$
(C) $O(n^3)$
(D) $O(\log n)$

Common Data for Questions 32 and 33:
Consider the given graph,

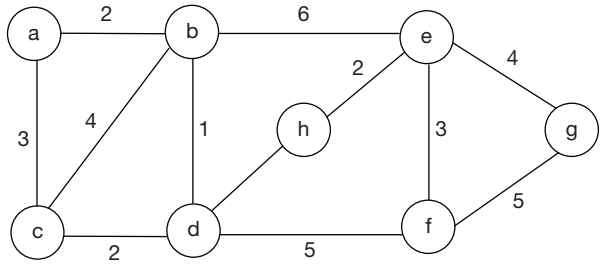


32. What is the eccentricity of node 'd'?
(A) 3 (B) 5
(C) 1 (D) 6

33. What is the center of given graph?
(A) Node 'a' (B) Node 'c'
(C) Node 'b'
(D) Either Node 'd' or Node 'e'

Statement for linked Answer questions 34 and 35:

34. Consider the given graph



Which of the following can be the sequence of edges added to minimum spanning tree using "Prims Algorithm"?

(A) $(a-b), (b-d), (d-c), (d-f), (f-g), (f-e), (e-h)$
(B) $(a-b), (b-d), (d-c), (d-f), (f-e), (e-g), (e-h)$
(C) $(e-h), (e-f), (e-g), (f-d), (d-b), (b-a), (d-c)$
(D) $(e-h), (e-f), (e-g), (d-b), (f-d), (b-a), (d-c)$

35. What is the total weight of spanning tree (correct edge sequence) identified in the above question?

(A) 17 (B) 19
(C) 20 (D) 21

Answer Keys

1. C	**2.** B	**3.** B	**4.** D	**5.** C	**6.** D	**7.** B	**8.** D	**9.** 8	**10.** C
11. A	**12.** 15	**13.** B	**14.** C	**15.** B	**16.** B	**17.** A	**18.** A	**19.** C	**20.** D
21. D	**22.** D	**23.** B	**24.** C	**25.** D	**26.** C	**27.** A	**28.** B	**29.** C	**30.** A
31. B	**32.** D	**33.** C	**34.** C	**35.** B					

Hints and Explanations

1. In worst case Linear search takes $O(n)$ time, whether it is ordered list (or) unordered List. Choice (C)

2. Recurrence Relation for Binary search is $T(n) = T(n/2) + \theta(1)$. Time complexity of Binary search is $\theta(\log n)$. Choice (B)

3. Randomly given 'n' numbers are to be sorted first, which takes $O(n \log n)$ time and return the $(n/2)$th element, that is the median of given 'n' random elements. Choice (B)

4. The basic solution is to have two loops and keep track of maximum count for all different elements. If maximum count becomes greater than $n/2$ then break the loops and return the element having maximum count. If maximum count doesn't become more than $n/2$ then majority element doesn't exist.
2 loops(nested) $\Rightarrow O(n^2)$. Choice (D)

5. Number of comparisons
If 'n' is even $\frac{3n}{2} - 2$
If 'n' is odd $\frac{3n}{2} - \frac{3}{2}$. Choice (C)

6. To find First Largest element $(n-1)$ comparisons are required, for second largest $(n-2)$, for Third largest $(n-3)$ and For fourth largest $(n-4)$.
$\therefore$ Total $\Rightarrow (n-1) + (n-2) + (n-3) + (n-4)$
$\therefore$ $4n - 10 \Rightarrow 2(2n-5)$.
Choice (D)

7. The algorithms makes $|V| - 1$ passes over the edges of the graph (E)
$(V-1) * E$
$O(V * E)$.
Choice (B)

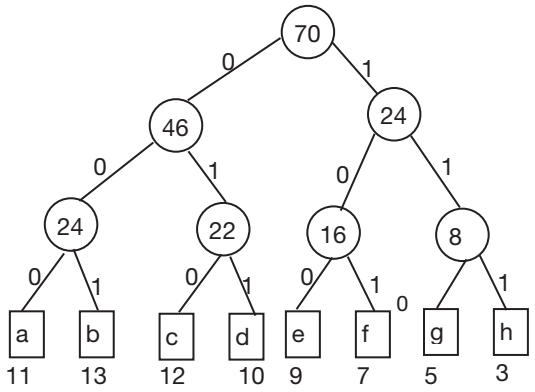
8. Linear Probing:
$h(k) = (2k+1) \bmod 8$
$h(3) = 7 \bmod 8 = 7$
$h(8) = 17 \bmod 8 = 1$
$h(16) = 33 \bmod 8 = 1$
(collision occurred at location 1)
Search for next empty slot
from the point of collision.
$h(9) = 19 \bmod 8 = 3$
$h(1) = 3 \bmod 8 = 3$ (collision)
$h(4) = 9 \bmod 8 = 1$ (collision). Choice (D)

9. str1 = A B R A C A D A B R O A
str2 = Y A B B A D A B B A D O O B A
The longest common subsequence would be A B A D A B O A.
The length is '8'.

10. The string form is $a^m b^{2n} c^{3p}$, $m, n, p \geq 2$.
i.e., The strings are *aabbbbccccc*, *aaabbbbbbccccccccc*, …….
The regular expression will be
$(aa)a^* (bbbb) (bb)^* (cccccc)(ccc)^*$
(minimum two a's four b's, six c's will be there in the string). Choice (C)

11. $0 < i < j$
$n^j \leq c * n^i$ which is false.
Choice (A)

12. **Fixed length coding:**



If there are 8 characters, 7 merging operations would be performed. In fixed length coding each character takes same number of encoded bits, each character takes 3-bits.

'*a b f e g*', 5 characters $\Rightarrow 5 \times 3 = 15$ bits.

13. In Depth First search Algorithm, First all elements (V) will be pushed onto stack and followed by (V) pop operations.

$\therefore$ Total $V * V = 2V$.

Choice (B)

14. Since the length of the given string is n, there are 'n' sub strings possible (excluding empty string) with first character. Similarly, $(n - 1)$ substrings possible with second character and so on.

Choice (C)

15. K-Regular graph (K_{n+1}-graph) that is complete graph. Hence $O(n^3)$. Choice (B)

16.

4	2	6	4	2	6

Sorted array:

2	2	4	4	6	6

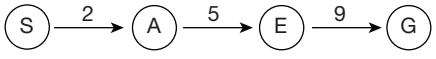
In the sorted array First repeating element is '2', but in the given array 4 is the first repeating element.

Sorted array in descending order:

6	6	4	4	2	2

In the sorted array (descending order), The first repeating element is '6'. Choice (B)

17. Greedy Approach, pick the least possible weight at each phase.



$\Rightarrow$ $2 + 5 + 9 = 16$. Choice (A)

18. Shortest distance from node 'u' to node 'v' is shown by $\delta(u, v)\ \delta(A, G) = \min\{6 + \delta(D, G), 5 + \delta(E, G)\}$

$\delta(C, G) = \min\{1 + \delta(F, G), 6 + \delta(F, G)\}$

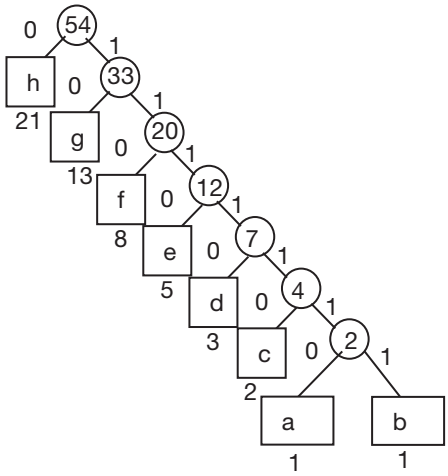
$\delta(E, G) = 9$

$\Rightarrow$ Back substitute the value

$\delta(E, G) = \min\{16, 4\} = 4$

$\delta(S, G) = \min\{16, 7, 6\} = 6$. Choice (A)

19. $a - 1, b - 1, c - 2, d - 3, e - 5, f - 8, g - 13, h - 21$



Huffman codes

a – 1111110

b – 1111111

c – 111110

d – 11110

e – 1110

f – 110

g – 10

h – 0

Given code 110 10 0 11110 110

f g h d f. Choice (C)

20. Queue

dequeue A, and enqueue its neighbours in lexicographic order

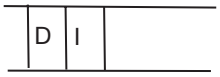
Dequeue B

Dequeue C

Dequeue E

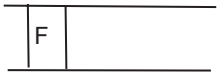
Dequeue G

Dequeue H



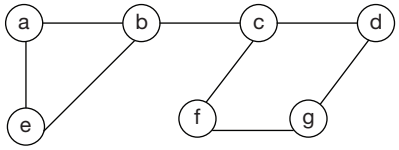
Dequeue D

Dequeue I



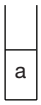
Dequeue F Choice (D)

21.

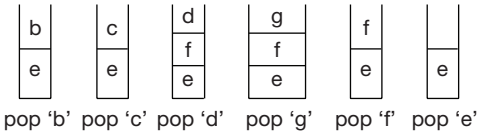


Choice (A)

a, b, c, d, g, f, e



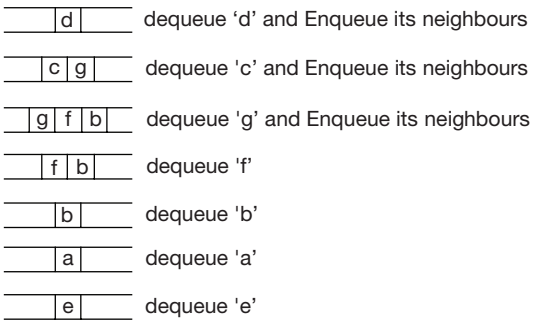
pop 'a' and push its neighbours



popped elements $\Rightarrow a, b, c, d, g, f, e$
In the same way check all the options.
Choice (D) is incorrect.

Choice (D)

22. Option (A): d, c, g, f, b, a, e



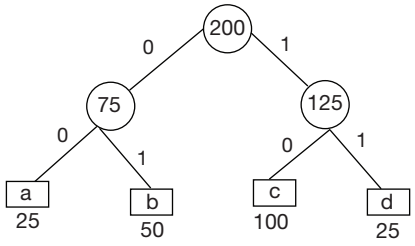
In the same way, check all the option, options (D) is incorrect. Choice (D)

23. $h(k) = k \bmod 10$

0	1	2	3	4	5	6	7	8	9
97	31	22	42	61	64	46	71	58	83

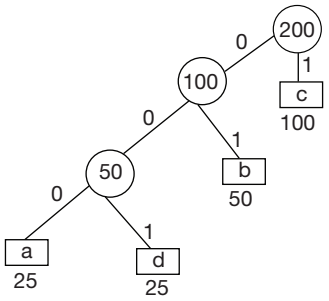
Linear Probing: when collision occurs, search for next empty slot from the place of collision, treat array as circular array. Choice (B)

24. $a - 25, b - 50, c - 100, d - 25$



After Encoding
a – 00(2 bits)
b – 01(2 bits)
c – 10(2 bits)
d – 11(2 bits)
Number of bits required
$= 25 \times 2 + 50 \times 2 + 100 \times 2 + 25 \times 2$
$= 50 + 100 + 200 + 50$
$= 400$ bits. Choice (C)

25. Variable Length Encoding is also called "Huffman coding"
Arrange the characters in increasing order
$a - 25, d - 25, b - 50, c - 100$



After Encoding:
a – 000 (3 bits)
b – 01 (2 bits)
c – 1 (1 bit)
d – 001 (3 bits)
Number of bits required
$= 25 \times 3 + 50 \times 2 + 25 \times 3 + 100 \times 1$
$= 75 + 100 + 75 + 100$
$= 350$ bits. Choice (D)

26. Arrange the tasks in decreasing order according to their profits.

T_5	T_2	T_4	T_3	T_1
4	2	1	1	2
60	50	40	30	20

T_4	T_2		T_5					

T_3 and T_1 cannot be executed because their deadlines are 1 and 2 respectively. Choice (C)

27. The executed Tasks are T_2, T_4 and T_5 and the profit made is 40 + 50 + 60 = 150. Choice (A)

28. The given code performs, For each input element, check whether there is any element with same value and for each such occurrence, increment the counter. Every time, check the current counter with the max and update it, if this value is greater than counter.
Choice (B)

29. There are 2 nested loops, each loop will be executed 'n' times
$\therefore \quad n \times n = O(n^2)$. Choice (C)

30. The given code performs sum of 2 array elements which is equal to given 'X' value. Choice (A)

31. Outer loop executes '$n + 1$' times
Inner loop executes '$n - 1$' times
$\therefore O(n^2)$. Choice (B)

32. Eccentricity of a node is the maximum of minimum path from other nodes to the given node.

$$\max \begin{cases} \text{Min path } (a-d) = 3 \\ \text{Min path } (b-d) = 5 \\ \text{Min path } (c-d) = 1 \\ \text{Min path } (e-d) = 6 \end{cases}$$

Eccentricity = 6 Choice (D)

33. Center of a graph is a node with minimum eccentricity.
Eccentricity of Node 'a'

$$\max \begin{cases} \text{dist } (b-a) = 3 \\ \text{dist } (c-a) = 6 \\ \text{dis } (d-a) = 7 \\ \text{dist } (e-a) = 4 \end{cases} = 7$$

Eccentricity of Node 'b'

$$\max \begin{cases} \text{dist } (a-b) = 2 \\ \text{dist } (c-b) = 3 \\ \text{dist } (d-b) = 4 \\ \text{dist } (e-b) = 1 \end{cases} = 7$$

Eccentricity of Node 'c'

$$\max \begin{cases} \text{dist } (a-c) = 2 \\ \text{dist } (b-c) = 4 \\ \text{dist } (d-c) = 8 \\ \text{dist } (e-c) = 5 \end{cases} = 8$$

Eccentricity of Node 'd' is given in the above solution that is '6'
Eccentricity of Node 'e'

$$\max \begin{cases} \text{dist } (a-e) = 4 \\ \text{dist } (b-e) = 6 \\ \text{dist } (c-e) = 2 \\ \text{dist } (d-e) = 3 \end{cases} = 6$$

Center of a graph is min of all eccentricities min (7, 4, 8, 6, 6) = Node. Choice (C)

34. If we start Prims Algorithm with edge $(a - b)$ the sequence will be
$(a-b), (b-d), (d-c), (d-f), (f-e), (e-h), (e-g)$
If it starts with edge $(e - h)$ the sequence will be
$(e-h)(e-f)(e-g), (f-d), (d-b), (b-a), (d-c)$.
Choice (C)

35. For the correct sequence
$(e-h)\ (e-f)\ (e-g), (f-d)\ (d-b)\ (b-a)\ (d-c)$
2 + 3 + 4 + 5 + 1 + 2 + 2 = 19. Choice (B)