DEPARTMENT OF INFORMATION TECHNOLOGY, NITK SURATHKAL

END SEMESTER EXAMINATION, NOVEMBER 2018

IT200: DATA STRUCTURES AND ALGORITHMS

Class: III SEM B.TECH (IT)
Date: 19/11/2018

Time: 3 Hrs.
Marks: 100

Register No. | 1 | 7 | I | T | 2 | 4 | 8 |

NOTE:
1. There are 8 questions in this paper.
2. Each question has multiple parts. Read the entire question carefully.
3. Use pseudo-code to describe algorithms, not C or Python code.

Problem 1 : [2+3+5 = 10 marks]

a) The popular high-school multiplication algorithm to multiply long numbers does a series of digit-by-digit multiplications, finally adding up all the intermediate products. Compute the time complexity of multiplying two n digit numbers with this algorithm, assuming that any single digit multiplication or addition takes O(1) time.

b) Arrange the following nine functions in order of increasing growth rate. If two functions are of the same growth rate, show that also.

$\sqrt{n}$ $\log n$ $\log\log n$ $n^{1/3}+\log n$ $(\frac{2}{3})^n$ $(\frac{4}{3})^n$ 2^n $n!$ $(\log n)^3$

c) Write Python code for a class **`UndirectedGraph`** which has just two attributes `n` and `M`, where n is the number of nodes and M is the adjacency matrix of the graph. Write a constructor with appropriate parameters that initialises the class attributes to the parameter values. Define a function **`getNumEdges`** within this class that returns the number of edges in the undirected graph.

Problem 2 : [4+6 = 10 marks]

a) Let Q denote a queue containing sixteen numbers and S be an empty stack. head(Q) returns the element at the head of the queue Q without removing it from Q. Similarly top(S) returns the element at the top of S without removing it from S. Consider the algorithm given below.

```
while Q is not Empty do
  if S is Empty OR top(S) ≤ head(Q) then
     x = dequeue(Q)
     push(S,x)
  else
     x = pop(S)
     enqueue(Q,x)
```

What is the maximum number of times that the while loop can iterate? Explain your answer.

b) A node of a doubly linked list has three attributes: `val`, `prev` and `next` denoting the value stored in a node, a reference to the previous and the next node in the list. Define the data type `DlistNode` with these three attributes. Given that the list has a sentinel node with a special value $-\infty$, write pseudo-code for a function `createNewDList` that creates an empty list. If moreover the list elements are kept in a non-decreasing order, write code for a function `sortedInsert(k,L)` that inserts the value k in the right place in the doubly linked list L.

Problem 3 : [2+3+4+5 = 14 marks]

a) In a hash table that uses double hashing, the table size m has been chosen to be a power of 2. Assume that the first hash function is $h_1(k) = k \bmod m$. Design a good offset hash function $h_2(k)$ which will ensure that all the table slots will be probed if necessary.

b) In a hash table with chaining, the expected time for an unsuccessful search is $O(1+\alpha)$. If a new hashing scheme keeps each of the linked lists in a sorted order, what would be the resulting runtime of an unsuccessful search, insert and delete operation? Give reasons for your answer.

c) What is the relation between the number of internal nodes and the number of leaves in a binary tree? How many leaves does a complete binary tree of n nodes have? Use this result to derive an asymptotic *lower* bound (using Ω notation) on the total time to do n inserts in any binary tree.

d) An application you are building requires the following operations:

`insert(x,S)`: insert element x into the set S
`delete(k,S)`: delete the k^{th} smallest element in S
`search(k;S)`: return True if set S contains an element with key k; False otherwise

Design a data structure that implements all these operations in O(log n) worst case time, where n is the number of elements in the set S. Clearly explain how your data structure implements each of the above operations, and also how the O(log n) runtime is achieved.

Problem 4 : [2+6+2 = 10 marks]

a) What is the minimum number of nodes in an AVL tree of height 5? Draw the structure of this tree (you can ignore the key values). Complete the following statement:

"In an AVL tree of height h, the leaf closest to the root is at level _____".

b) The following operations are performed sequentially on an (initially empty) AVL tree:
insert(10), insert(5), insert(8), insert(12), insert(16), insert(20), delete(12), delete(16).
Show the resulting AVL tree after each operation. Also show intermediate rotation(s) (if any). During deletions, whenever appropriate, replace a node by its successor (and not predecessor).

c) Is the **delete** operation in AVL trees commutative? That is, if two nodes n_1 and n_2 are deleted from an AVL tree is the resulting tree the same irrespective of the order in which nodes n_1 and n_2 are deleted? Is the **insert** operation in AVL trees commutative? Give reasons for your answer.

Problem 5 : [2+5+3+4 = 14 marks]

a) Can a Red-Black tree have a black node which has exactly one black child and no red child? Give reasons for your answer.

b) Show that the height of a Red-Black tree of n nodes is $\Theta(\log n)$. What is the maximum height of a Red-Black tree with 14 nodes ? Draw a Red-Black tree of 14 nodes which attains this maximum height. (Hint: The black depth of every external node in this tree is 3).

c) A complete binary min-heap is made by including each integer in [1, 1023] exactly once. The depth of a node in the heap is the length of the path from the root of the heap to that node. Thus, the root is at depth 0. What is the maximum depth at which integer 9 can appear? Give reasons.

d) A binary min-heap is created containing the 14 keys S T R U C T U R E D D A T A. Show the resulting heap if it is created by inserting the keys one by one, starting from S. What is the heap if it is built using the 'buildHeap' operation? Use a lexicographic order on the keys (A < B < C...etc).

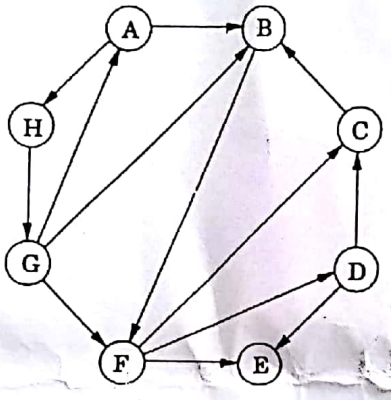
Problem 6 : [8+6 = 14 marks]

a) The square of a directed graph G=(V,E) is the graph $G^2=(V,E^2)$ such that (u,v) is an edge in E^2 if and only if G contains a path with at most two edges between u and v. Given the adjacency-list representation of G, give an efficient algorithm to compute the adjacency-list representation of G^2. Compute the runtime of your algorithm.

b) Write pseudo-code for a function `hasOddCycle` that takes as input an undirected graph G=(V,E) and returns True if the graph has a cycle of odd length. Return False otherwise.

Problem 7 : [6+2+4 = 12 marks]

a) Perform a depth-first search on the graph below starting from vertex A. Whenever there is a choice of vertices to explore, pick the one that is alphabetically first. What is the sequence of vertices explored? Draw the final DFS tree, showing the time stamps of each vertex. Explicitly label the tree edges, forward edges, back edges and cross edges in your DFS tree.



b) Assume that our DFS procedure explores the entire graph, that is, if at the end of a DFS with a given source vertex there are still unvisited vertices, then DFS is restarted on an unvisited vertex till all the graph vertices are visited. This results in a depth-first *forest* , a collection of DFS trees, one for each of the restarted DFS. In such a case is it possible that for a given vertex v which has both incoming and outgoing edges, its DFS tree contains no vertex other than v? If yes, give an example for this, if no, argue why not.

c) Give an example of a graph with negative edge weights for which Dijkstra's algorithm fails to compute the shortest path between two vertices. Suppose we modify a graph G with negative weight edges in the following way: add a large constant to each edge such that all the resulting edge weights become positive. If we run Dijkstra's algorithm on this modified graph from a source vertex s, will the actual shortest paths (not the path lengths) be the same as in the original graph G?

Problem 8: [2+7+7= 16 marks]

a) What is a stable sorting algorithm? Is Mergesort a stable sorting algorithm? If yes, explain precisely how stability is acheived. If no, give reasons why.

b) With the help of a suitable example explain the Divide, Conquer and Combine phases of Quicksort. State one advantage of Quicksort over Mergesort.

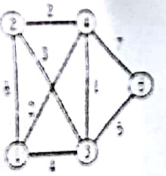
c) Write a pseudo-code for insertion sort algorithm. Assume your input is A[0..n-1], an unsorted array of n numbers. What is the worst-case runtime of the algorithm? When does this occur?

National Institute of Technology Karnataka
Department of Mathematical and Computational Sciences
End Semester Examination
MA200: Mathematical Foundations of Information Technology
9.00 a.m. - 12.00 p.m., 22/11/2018

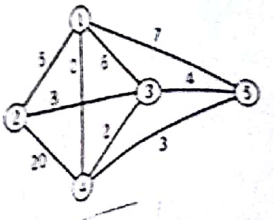
Time : 3 hours **Max Marks : 100** **Roll No.....**

Instructions:
(i) Do not do any rough work on the question paper.
(ii) Calculators are not allowed.
(iii) A table containing values of the Standard Normal Distribution Function are given on the last page.

1. Do the indexing of your answer booklet. (2)
2. G is a tree of order $n > 1$. Is it possible that G^c is also a tree? Either give an example of such G and G^c or explain why such an example cannot exist. (6)
3. Prove that a graph of n vertices is a tree if and only if it is acyclic and has $n - 1$ edges. (6)
4. For the weighted graph below, use Kruskal's Algorithm to find a minimal spanning tree. Clearly indicate the edges which you are selecting at various stages. Also find the weight of the minimal spanning tree. (4)



5. For the weighted graph below, use Prim's Algorithm to find a minimal spanning tree. Start with vertex 2. Clearly indicate the edges which you are selecting at various stages. Also find the weight of the minimal spanning tree. (4)



6. Does there exist a simple graph of eight vertices $v_1, v_2, \ldots, v_8$, such that $\deg(v_1) = 2$, $\deg(v_2) = \deg(v_3) = \deg(v_4) = \deg(v_5) = \deg(v_6) = 3$, $\deg(v_7) = 4$, $\deg(v_8) = 5$? Justify your answer. (4)

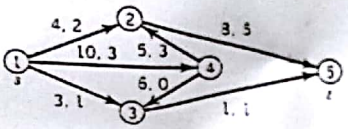
7. The probability that A hits a target is $1/4$ and the probability that B hits it is $2/5$. What is the probability that the target will be hit if A and B each shoot at the target? (4)

8. The figure below shows a flow network on which a flow from vertex 1 to vertex 5 is shown.

   (a) What is the value of this flow? (2)

   (b) Is this a maximum flow from vertex 1 to vertex 5 in this graph? If not, find a maximum flow from vertex 1 to vertex 5. (3)

   (c) Find a corresponding minimum cut. (3)



9. Suppose that four applicants a_1, a_2, a_3 and a_4 are available to fill six vacant positions p_1, p_2, p_3, p_4, p_5 and p_6. Applicant a_1 is qualified to fill position p_2 or p_5. Applicant a_2 can fill p_2 or p_5. Applicant a_3 is qualified for p_1, p_2, p_3, p_4 or p_6. Applicant a_4 can fill jobs p_2 or p_5. Use Ford-Fulkerson Algorithm to find the maximum number of positions that can be filled from the given set of applicants. (4)

10. If the number of elements in a set A is 2 and 20 in set B, then what is the probability that a mapping from A to B a one-one function? (4)

11. Suppose the relationship between quantity and time for radioactive decay for a certain isotope can be expressed in following way:

$$\frac{dg(t)}{dt} = -\lambda g(t), \qquad g(0) = N,$$

where $\lambda > 0$ is a fixed constant. Consider a probability model for the above. Let the random variable X denote the time at which a specific atom decays.

   (a) Find the probability that an atom decays in the time interval $[4, 5]$. (3)

   (b) Find the cumulative distribution function of X. (2)

   (c) Find the probability density function of X. (2)

12. Calls come into a telephone switchboard at a rate of 4 per minute. (2)
(a) Find the probability of exactly 6 calls in a minute. (3)
(b) Find the probability of at least 3 calls in 3 minutes.

13. Five fair coins are tossed simultaneously. Let the random variable X indicate the number of heads.
(a) Compute the probabilities of obtaining no heads, precisely 1 head, at least 1 head, not more than 4 heads. (5)
(b) Find the probability mass function of X. (3)

14. Suppose that 4% of steel rods made by a machine are defective, the defectives occurring at random during production. If the rods are packaged 100 per box, what is the Poisson approximation of the probability that a given box will contain (a) 4 defectives, (b) at least 5 defectives? (5)

15. If the mathematics scores of the SAT college entrance exams are normal with mean 480 and standard deviation 100 and if some college sets 500 as the minimum score for new students, what percent of students will not reach that score? (4)

16. Let X be normal with mean 4.2 and variance 0.04. Determine c such that
(a) $P(X > c) = 10\%$, (b) $P(-c < X - 4.2 \leq c) = 99\%$. (4)

17. A random variable X has a Poisson distribution with mean 7. Compute $E[(X + 5)^2]$. (5)

18. A fair die is tossed 180 times. Find the probability that the face 6 will appear between 31 and 35 times inclusive, using the normal approximation to the Binomial distribution. (5)

19. Consider a simple graph G which is Eulerian. (5)
(a) If G has 25 vertices, is it possible to deduce that G^c is Eulerian? Explain.
(b) If G has 32 vertices, is it possible to deduce that G^c is not Eulerian? Explain.

20. G is a simple graph with 9 vertices and 27 edges. Explain clearly if it possible to deduce that (6)
(a) G has a cycle of length 8?
(b) G has a cycle of length 7?
(c) G has a cycle of length 6?

TABLE 1. Values of the Standard Normal Distribution Function*

$$\Phi(z) = \int_{-\infty}^{z} \frac{1}{\sqrt{2\pi}} e^{-u^2/2}\, du = P(Z \le z)$$

z	0	1	2	3	4	5	6	7	8	9
−3.0	0.0013	0.0010	0.0007	0.0005	0.0003	0.0002	0.0002	0.0001	0.0001	0.0000
−2.9	0.0019	0.0018	0.0017	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
−2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
−2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
−2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
−2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
−2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
−2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
−2.2	0.0139	0.0136	0.0132	0.0129	0.0126	0.0122	0.0119	0.0116	0.0113	0.0110
−2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
−2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
−1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0238	0.0233
−1.8	0.0359	0.0352	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0300	0.0294
−1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
−1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
−1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0570	0.0559
−1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0722	0.0708	0.0694	0.0681
−1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
−1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
−1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
−1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
−0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
−0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
−0.7	0.2420	0.2389	0.2358	0.2327	0.2297	0.2266	0.2236	0.2206	0.2177	0.2148
−0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
−0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
−0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
−0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
−0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
−0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
−0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641

TABLE 1 (*Continued*)

$$\Phi(z) = \int_{-\infty}^{z} \frac{1}{\sqrt{2\pi}} e^{-u^2/2}\, du = P(Z \le z)$$

z	0	1	2	3	4	5	6	7	8	9
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7703	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9278	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9430	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9648	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9700	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9762	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9874	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9990	0.9993	0.9995	0.9997	0.9998	0.9998	0.9999	0.9999	1.0000

DEPARTMENT OF INFORMATION TECHNOLOGY, NITK SURATHKAL
END SEMESTER EXAMINATION, NOVEMBER 2018
IT202: UNIX PROGRAMMING AND PRACTICE

Class: III SEM B.TECH (IT) **Time: 3 Hrs**
Date: 24/11/2018 **Marks: 80**

Register No. | 1 | 7 | I | T | 2 | 4 | 8 |

NOTE: Answer all the Questions to the Point only.

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1. Analyse the following commands and provide the output (if possible): (20M)
   (a) cd --
   (b) tr "AB" "*?" <file1 | tr "*?" "BA"
   (c) sort –t '/' –u +1 -2 file1
   (d) cut –c30-50 file1
   (e) comm -13 file1 file3
   (f) ps --e --forest
   (g) top
   (h) sed 's/;$/ /' file1
   (i) grep "u^" file1
   (j) bg %?com

2. Consider a database given below and use one line command to find: (6M)

ID	Name	Hours Worked	Hourly pay($)
1435	Juan	18	14.5
4311	George	17	19.5
6781	Anne	44	16.7
1451	Ben	36	18.6
3377	Tuan	14	15.5

   (a) The names of employees who worked more than 19 hours.
   (b) The id and hours worked for employees who earn more than $17.
   (c) Id, name and hourly pay for employees who worked fewer than 15 hours.

3. (a) Consider a user issue a umask 211 command, will the other user and owner have the write permission? (4M)
   (b) Devise a command to determine if this year is a leap year. (4M)
   (c) Suppose you are an admin, using command how will you monitor the current processes of the user? (2M)

for both needs create file and directory

4. If file1 has 100 line, file2 has 50 lines, and file3 has 80 lines, how many lines will file3 have after each of the following commands (each command is independent)? (6M)
   (a) head -20 file1 > file3
   (b) tail +20 file1 > file3
   (c) head -21 file1 | head -50 >file3

5. (a) By considering the following example, prove that **cat** utility is a filter.
   cat file1 | cat | cat
   (b) If we use **tee file1 file2 file3** command, where does the input file come from and how many output files will be created? (4M)
   (c) How will you change the default priority of a process with an example? (4M)

6. Given the following regular expression, show some strings (minimum 3) which are matched by these regular expressions. (3M)
   (a) :?.?
   (b) ^\$[0-9]*[^0-9]$
   (c) \..\{3\}$ (6M)

7. (a) While doing a search using grep command, how will you ignore some particular words? (2M)
   (b) Devise a command using sed, to move lines 33 to 44 after line 56 in file. (2M)
   (c) Determine number of processes created and how by the following code. (6M)

```
int i;
for(i=0;i<4;i++)
fork( );
return 0;
}
```

8. Write a regular expression to match the following
   (a) Blank lines
   (b) Non blank lines (3M)

9. Differentiate between
   (a) Orphans and Zombie process.
   (b) SIGTERM and SIGKILL in kill command using an example. (8M)
   (c) Init process and any other parent process in the system.

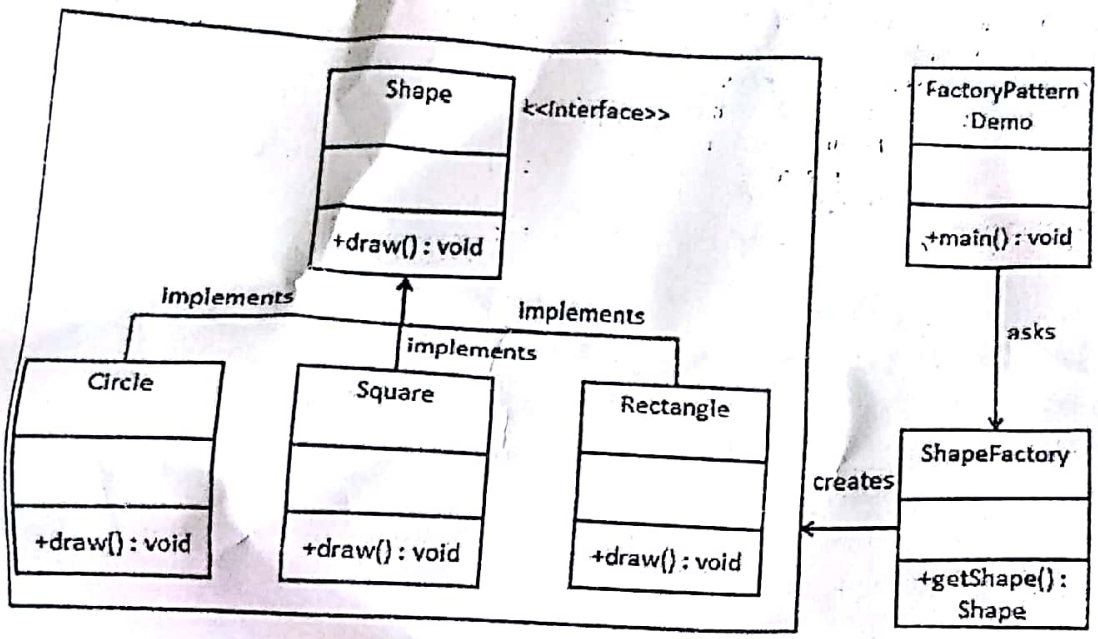
-----ALL THE BEST-----

17IT248

DEPARTMENT OF INFORMATION TECHNOLOGY, NITK SURATHKAL
END SEMESTER EXAMINATION, NOVEMBER 2018
III Sem B.Tech (IT). IT206 Paradigms of Programming

Note: All Questions Carry Equal Marks. Time 3 Hours. Marks 100

1. Implement the factory pattern using Java application (use Swing to draw the real shapes)?



2. Create a Singleton Class which is not thread safe. Create two or more derived classes which extend from Thread class inside these derived classes create the instances of singleton class. How will you test whether more than instance of the singleton class is created or not?

3. This application will support the operations of a technical library for a university department. This includes the searching for and lending of technical library materials, including books, videos, and technical journals. All library items have registration code (research area code + running number). Each borrower can borrow up to 10 items. Each type of library item can be borrowed for a different period of time (books 6 weeks, journals 3 days, videos 1 week). If returned after their due date, the employee will be charged a fine, based on the type of item (books 5:-/day, journals and videos 20:-/day).Materials will be lent to employees only if they have (1) no overdue lendable, (2) fewer than 10 articles out, and (3) total fines less than 100

Draw relevant diagrams for the above case study which may lead to complete class structure?

4. Find the prime numbers between 1000 to 5000 :
   Thread 1: will find prime numbers between 1000 to 2000
   Thread 2: will find prime numbers between 2000 to 3000
   Thread 3: will find prime numbers between 3000 to 4000
   Thread 4: will find prime numbers between 4000 to 5000
   Print it in ascending and descending order?

5. Consider the following numbered (from 1 to 13) jumbled Fragments of the program code from the class ToDoList

```
1. if (isDone()) s = s + "has been done";
     else s = s + "has not been done";

2. public ToDoList (String item, boolean done){
                    ToDoList.
3. public class ToDOList{

4. public static void main (String [] args){

5. this.item = item;
   this.done = done;
   }

6. return s;
   }

7. public String toString(){

   String s = ("The to do list item: "+item+ "\n ");

8. private String item;
   private String done;

9. return done; }

10. System.out.println(toDoList);

11 . }
   }

12. ToDoList toDoList = new ToDoList ("take cat to Vet",false);

13. public boolean isDone(){
```

Using all the code fragments (and nothing else) write the object oriented ToDoList class. Your completed class should able to output:
"The to do list item take cat to Vet has not been done".

DEPARTMENT OF INFORMATION TECHNOLOGY, NITK SURATHKAL

END SEMESTER EXAMINATION, NOVEMBER 2018

IT203: Computer Systems Organization Lab

Class: III SEM B.TECH (IT) Time: 3 Hrs.

Date: 28/11/2018 Marks: 50

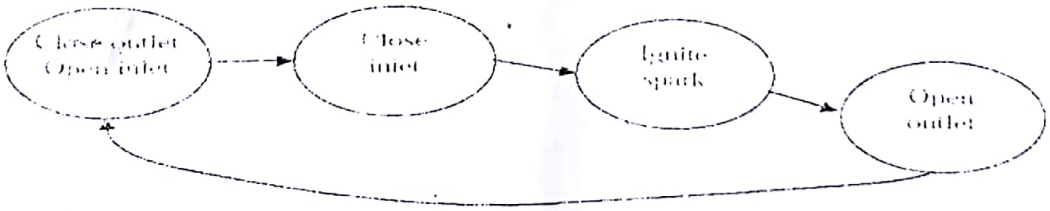
Register No. | | | | | | | |

NOTE:1. Answer All Questions with suitable steps/procedure

---

1. An engine needs to go through four strokes, all of equal duration (see figure for state sequence). On the first stroke the inlet valve is open and the outlet is closed; on the second stroke the inlet is closed; on the third stroke a spark is delivered; and on the fourth stroke the outlet is open for the exhaust explosion to vent. Then the first stroke comes again and the cycle repeats. Design a controller for the system, with a clock for input and with three outputs: one to open the inlet, one to open the outlet, and one to ignite the spark. Assume that if the control to open a valve isn't asserted, the valve closes (spring-loaded valve). The frequency of the clock will determine the speed of engine. Use J-K flip flop for this design.

(Use Grey code to assign flip flop outputs to the states)



State sequence of engine cycle

[20M]

2. Design a sequential circuit with two D flip-flops A and B, and one input x. When x = 0, the state of the circuit remains the same. When x = 1, the circuit goes through the state transitions from 00 to 01, 01 to 11, 11 to 10, 10 back to 00, and repeats.

[15M]

3. Write a 8086 ALP program to input a hex character and display it as many times as that of the hex character.

[15M]

DEPARTMENT OF INFORMATION TECHNOLOGY, NITK SURATHKAL

END SEMESTER EXAMINATION, NOVEMBER 2018

IT203: Computer Systems Organization Lab

Class: III SEM B.TECH (IT)

Time: 3 Hrs.

Date: 28/11/2018

Marks: 50

Register No. | 1 | 7 | F | T | 2 | 4 | 8 |

NOTE:1. Answer All Questions with suitable steps/procedure

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4. Make an electronic dice using three JK-Flip Flops A, B, C, and one input x; When x = 1, the circuit goes through the state transitions from 1 to 2, 2 to 3, 3 to 4, 4 to 5, 5 to 6, 6 back to 1 and repeats. When x = 0, the circuit does not change its state. [20M]

5. Design a sequential circuit with two JK FFs A and B, and two inputs E and x. If E=0, the circuit remains in the same state, regardless of the value of x. When E = 1 and x = 1, the circuit goes through the state transitions from 00 to 01, 01 to 10, 10 to 11, 11 to 00 and repeats. When E = 1 and x = 0, the circuit goes through the state transitions from 00 to 11, 11 to 10, 10 to 01, 01 to 00 and repeats. [15M]

6. Write a MASM program to print Fibonacci series.

   Note: Display the series only as numbers and not the ASCII values [15M]