

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations 2021-2022

Sub: **CSE 411 (Simulation and Modeling)**

Full Marks: 210

Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Question No. 1 is **mandatory**. Answer any **TWO** questions from the Question No. 2, 3 and 4.

All relevant tables and figures are provided at the end of the question

1. (a) For the single sever queueing system, $Q(t)$ denotes the number of customers in the queue at time t , for any real number $t \geq 0$. Let $L(t)$ be the total number of customers in the system at time t (including the queue and the customer is service at time t , if any). Ross claims that $L(t) = Q(t) + 1$. Do you agree with Ross? Justify your answer. (10)
- (b) A discrete probability distribution is used to generate the following samples: 23, 14, 14, 3, 16, 12, 6, 2, 18, 22, 15, 4, 16, 15, 16. Develop a distribution that best represents the data, using the necessary summary statistics. Estimate the parameter(s) of the distribution. (10)
- (c) MessiJerseys Co. specializes in selling Lionel Messi's jerseys exclusively at the BUET campus. The company has implemented an inventory system to manage and track the sales of Messi's jerseys. Demonstrate the inventory system for this company, (15)
 which only sells Messi's jerseys. The demand arrives at the beginning of each day. The demand sizes (daily demand) are IID random variables with the probability distribution provided in Table 2. The inventory is reviewed at the end of each day, and the (s, S) policy is followed, where $s = 30$, $S = 40$. Once a refill order is placed, it may arrive within the next one to four days and arrive at the end of the day. The lead time is a random variable that follows a probability distribution provided in Table 3. If the order is placed on Day x and the lead time random variable is y , then the order arrives at the end of Day $(x + y)$. Also, if the order is placed on Day x , no refill order can be placed within the next four days. This means the next refill order can be placed (if needed) at the end of the day $(x + 4 + 1)$. Assume the initial inventory at day zero is 40. Fill up the table and calculate the total cost after the end of Day 10. Assume no set up cost, and incremental order cost of \$3 per item, a holding cost of $h = \$1$ per item per day, and a backlog cost of $p = \$5$ per item per day. There are 30 U (0, 100) numbers provided in Table. 1. You must use them sequentially whenever you need to obtain demand sizes and lead times.

[You may modify figure. 1 (separate sheet) and attach the updated figure with your answer script.]

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2. (a) Answer the following question regarding various probability distributions: **(3+3+4)**

- i. Provide one example of a probability distribution that is parameterized only by the shape parameters.
- ii. What are the relationships between geometric and negative binomial distributions?
- iii. If X_1, X_2, \dots, X_k are independent standard normal random variables, then what is the distribution of $X_1^2 + X_2^2 + \dots + X_k^2$?

(b) Cooper Auto Windows, under the visionary leadership of Sheldon Cooper, develops a groundbreaking plastic protective material surpassing conventional thickness standards. To use this material, however, the production machinery must be adjusted. A trial adjustment was made on one of the 10 machines used in production, and a sample of 25 windshields was measured. This sample had a mean thickness of 2.9 mm. Using the population standard deviation of 0.25 mm, does the adjustment provide for a smaller thickness in the material than the old adjustment (4 mm)? (Use a hypothesis test with a level of significance of 0.01. Assume the distribution of thickness is approximately normal.) **(10)**

(c) Suppose that X and Y are jointly continuous random variables with **(5+10)**

$$f(x, y) = \begin{cases} 24xy, & \text{for } x \geq 0, y \geq 0, \text{ and } x + y \leq 1 \\ 0 & , \text{otherwise} \end{cases}$$

- i. Show that X and Y are not independent
- ii. Compute $\text{Var}(2X + 3Y + 7)$

3. (a) Show that if n is sufficiently large, an approximate $100(1-\alpha)$ percent confidence interval for μ (population mean) is given by $\bar{X}(n) \pm z_{1-\alpha/2} \sqrt{\frac{S^2(n)}{n}}$, where symbols carry usual meanings. **(10)**

(b) An astronomer has recently discovered n similar galaxies. for $i = 1, \dots, n$, let X_i denote the number of black holes in the i-th galaxy, and assume the X_i are independent Poisson (λ) random variables. **(10)**

- i. find the probability that at least one of the galaxies contains two or more black holes.
- ii. Find the probability that all n galaxies have at least one black hole.

(c) Let $\{X(t), t \geq 0\}$ be such that $X(t) = A + Bt + Ct^2$, in which A, B, and C are independent random variables, each with a mean of 1 and a variance of 1. Is this process covariance stationary? **(15)**

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4. (a) Consider ten numbers: 1.5, 6.0, 8.5, 5.6, 4.3, 1.9, 2.2, 4.6, 6.7, and 9.4. Define a continuous, piecewise-linear distribution function from these data, and plot the graph for this function. (10)

(b) A random sample of 395 people was surveyed, and each person was asked to report the highest education level they obtained. The data that resulted from the survey is summarized in the following table: (10)

	High School	Bachelors	Masters	Ph.d.	Total
Female	60	54	46	41	201
Male	40	44	53	57	194
Total	100	98	99	98	395

Given the data collected above, is there a relationship between the gender of an individual and the level of education that they have obtained at a 5% level of significance? (Use the χ^2 test statistic.)

(c) Suppose in a groundbreaking genetic discovery, Amy Farrah Fowler uncovers a new gene. This particular gene occurs as one of two alleles (M and m), where allele M has frequency θ in the population. That is, a random copy of the gene is M with probability θ and m with probability $1-\theta$. Since a diploid genotype consists of two genes, the probability of each genotype is given by: (15)

genotype	MM	Mm	mm
Probability	θ^2	$2\theta(1-\theta)$	$(1-\theta)^2$

Suppose Amy test a random sample of people and find that k_1 are MM, k_2 are Mm, and k_3 are mm. Find the MLE of θ .

SECTION – B

There are **FOUR** questions in this section. Question No. 5 is **mandatory**. Answer any **TWO** questions from the Question No. 6, 7 and 8.

5. (a) Prove the validity of the Inverse-Transform method. Discuss the general advantages and disadvantages of this method. (10)

(b) Plot the density f :

Apply the composition technique and provide detailed description of the decomposed variates to generate random variates from f . (20)

$$f(x) = \begin{cases} 0 & \text{if } x \leq 0 \\ \frac{3x}{4} & \text{if } 0 \leq x \leq \frac{2}{3} \\ \frac{19+9x}{50} & \text{if } \frac{2}{3} \leq x \leq \frac{16}{9} \\ \frac{22-9x}{12} & \text{if } \frac{16}{9} \leq x \leq \frac{22}{9} \\ 0 & \text{if } x \geq \frac{22}{9} \end{cases}$$

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Contd...Q no. 5

(c) How can you generate random variates form $gamma(7,4)$ distribution? (5)

6. (a) Find the density of Lognormal distribution using the density of the Normal distribution. (10)

(b) If $X \sim LN(\mu, \sigma^2)$ with $E(X) = 10$ and $Var(X) = 4$, write an algorithm to generate X form appropriate Normal distribution. (10)

(c) Describe the algorithm to generate random variates form the Normal distribution of **Question 6(b)** using the Acceptance-Rejection and Polar methods. (15)

7. (a) Generate two $Poisson(6)$ random variates using the following sequence of $U(0, 1)$ variates. (10)

0.856	0.329	0.874	0.758	0.093	0.805	0.296	0.048	0.458	0.428
0.127	0.711	0.698	0.012	0.029	0.917	0.682	0.521	0.448	0.584

Table for Question 7(a): 20 $U(0, 1)$ variates

How many random number will be required on average to generate one such Poisson variate?

(b) For the following densities, write the steps of Inverse-Transform method for generating random variates: (15)

1. Logistic Distribution ($Logistic(\mu, s)$):

$$f(x) = \frac{e^{-(x-\mu)/s}}{s(1 + e^{-(x-\mu)/s})^2} ; x \in (-\infty, \infty)$$

2. Cauchy Distribution ($Cauchy(\sigma)$):

$$f(x) = \frac{\sigma}{\pi(x^2 + \sigma^2)} ; x \in (-\infty, \infty)$$

(c) Discuss some general perspectives on the validation and accreditation issues of a simulation model. (10)

8. (a) Why is the Acceptance-Rejection method valid? Calculate the expected number of iterations required until an X is successfully generated by this algorithm. (8)

(b) Derive an Acceptance-Rejection algorithm to generate random variates from: (12)

$$f(x) = \begin{cases} 5x^4 & \text{if } x \in [0, 1] \\ 0 & \text{otherwise} \end{cases}$$

Also draw the majorizing function for $f(x)$.

(c) Write the algorithm to generate $X \sim beta(5,1)$ form the exponential distribution. (10)

(d) How do Antithetic Variates help reduce the variance? (5)

Random No Serial	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Random Number (U(0,100))	81	11	75	14	83	85	56	80	1	55	91	61	79	23	19
Random No Serial	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Random Number (U(0,100))	13	54	15	71	29	32	81	35	60	90	86	28	30	60	89

Table 1: Table for Question 1(c): 30 Random Numbers

Demand per day	Probability	Cumulative Probability	Random Number Interval
2	0.05	0.05	00-04
3	0.07	0.12	05-11
4	0.09	0.21	12-20
5	0.15	0.36	21-35
6	0.20	0.56	36-55
7	0.21	0.77	56-76
8	0.10	0.87	77-86
9	0.07	0.94	87-93
10	0.06	1.00	94-99

Table 2: Table for Question 1(c): Probability distribution of demand per day.

Lead Time (Days)	Probability	Cumulative probability	Random Number Interval
1	0.20	0.20	00- 19
2	0.30	0.50	20-49
3	0.35	0.85	50-84
4	0.15	1.00	85-99

Table 3: Table for Question 1(c): Probability distribution of lead time.

Day	Use U (0,100) Random Variates for Demand Size	Demand for Day	Use U (0,100) Random Variates for Lead time	Lead time	Inventory at the end of Day	Quantity received for Order arrival	Ordering Cost	Holding Cost	Backlog Cost
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

Figure 1: Table for Question 1(c).

d.f.	.995	.99	.975	.95	.9	.1	.05	.025	.01
1	0.00	0.00	0.00	0.00	0.02	2.71	3.84	5.02	6.63
2	0.01	0.02	0.05	0.10	0.21	4.61	5.99	7.38	9.21
3	0.07	0.11	0.22	0.35	0.58	6.25	7.81	9.35	11.34
4	0.21	0.30	0.48	0.71	1.06	7.78	9.49	11.14	13.28
5	0.41	0.55	0.83	1.15	1.61	9.24	11.07	12.83	15.09
6	0.68	0.87	1.24	1.64	2.20	10.64	12.59	14.45	16.81
7	0.99	1.24	1.69	2.17	2.83	12.02	14.07	16.01	18.48
8	1.34	1.65	2.18	2.73	3.49	13.36	15.51	17.53	20.09
9	1.73	2.09	2.70	3.33	4.17	14.68	16.92	19.02	21.67
10	2.16	2.56	3.25	3.94	4.87	15.99	18.31	20.48	23.21
11	2.60	3.05	3.82	4.57	5.58	17.28	19.68	21.92	24.72
12	3.07	3.57	4.40	5.23	6.30	18.55	21.03	23.34	26.22
13	3.57	4.11	5.01	5.89	7.04	19.81	22.36	24.74	27.69
14	4.07	4.66	5.63	6.57	7.79	21.06	23.68	26.12	29.14
15	4.60	5.23	6.26	7.26	8.55	22.31	25.00	27.49	30.58
16	5.14	5.81	6.91	7.96	9.31	23.54	26.30	28.85	32.00
17	5.70	6.41	7.56	8.67	10.09	24.77	27.59	30.19	33.41
18	6.26	7.01	8.23	9.39	10.86	25.99	28.87	31.53	34.81
19	6.84	7.63	8.91	10.12	11.65	27.20	30.14	32.85	36.19
20	7.43	8.26	9.59	10.85	12.44	28.41	31.41	34.17	37.57
22	8.64	9.54	10.98	12.34	14.04	30.81	33.92	36.78	40.29
24	9.89	10.86	12.40	13.85	15.66	33.20	36.42	39.36	42.98
26	11.16	12.20	13.84	15.38	17.29	35.56	38.89	41.92	45.64
28	12.46	13.56	15.31	16.93	18.94	37.92	41.34	44.46	48.28
30	13.79	14.95	16.79	18.49	20.60	40.26	43.77	46.98	50.89
32	15.13	16.36	18.29	20.07	22.27	42.58	46.19	49.48	53.49
34	16.50	17.79	19.81	21.66	23.95	44.90	48.60	51.97	56.06
38	19.29	20.69	22.88	24.88	27.34	49.51	53.38	56.90	61.16
42	22.14	23.65	26.00	28.14	30.77	54.09	58.12	61.78	66.21
46	25.04	26.66	29.16	31.44	34.22	58.64	62.83	66.62	71.20
50	27.99	29.71	32.36	34.76	37.69	63.17	67.50	71.42	76.15
55	31.73	33.57	36.40	38.96	42.06	68.80	73.31	77.38	82.29
60	35.53	37.48	40.48	43.19	46.46	74.40	79.08	83.30	88.38
65	39.38	41.44	44.60	47.45	50.88	79.97	84.82	89.18	94.42
70	43.28	45.44	48.76	51.74	55.33	85.53	90.53	95.02	100.43
75	47.21	49.48	52.94	56.05	59.79	91.06	96.22	100.84	106.39
80	51.17	53.54	57.15	60.39	64.28	96.58	101.88	106.63	112.33
85	55.17	57.63	61.39	64.75	68.78	102.08	107.52	112.39	118.24
90	59.20	61.75	65.65	69.13	73.29	107.57	113.15	118.14	124.12
95	63.25	65.90	69.92	73.52	77.82	113.04	118.75	123.86	129.97
100	67.33	70.06	74.22	77.93	82.36	118.50	124.34	129.56	135.81

Figure 2: Chi-square Distribution Table

n	0.6000	0.7000	0.8000	0.9000	0.9333	0.9500	0.9600	0.9667	0.9750	0.9800	0.9833	0.9875	0.9900	0.9917	0.9938	0.9950
1	0.325	0.727	1.376	3.078	4.702	6.314	7.916	9.524	12.706	15.895	19.043	25.452	31.821	38.342	51.334	63.657
2	0.289	0.617	1.061	1.886	2.456	2.920	3.320	3.679	4.303	4.849	5.334	6.205	6.965	7.665	8.897	9.925
3	0.277	0.584	0.978	1.638	2.045	2.353	2.605	2.823	3.182	3.482	3.738	4.177	4.541	4.864	5.408	5.841
4	0.271	0.569	0.941	1.533	1.879	2.132	2.333	2.502	2.776	2.999	3.184	3.495	3.747	3.966	4.325	4.604
5	0.267	0.559	0.920	1.476	1.790	2.015	2.191	2.337	2.571	2.757	2.910	3.163	3.365	3.538	3.818	4.032
6	0.265	0.553	0.906	1.440	1.735	1.943	2.104	2.237	2.447	2.612	2.748	2.969	3.143	3.291	3.528	3.707
7	0.263	0.549	0.896	1.415	1.698	1.895	2.046	2.170	2.365	2.517	2.640	2.841	2.998	3.130	3.341	3.499
8	0.262	0.546	0.889	1.397	1.670	1.860	2.004	2.122	2.306	2.449	2.565	2.752	2.896	3.018	3.211	3.355
9	0.261	0.543	0.883	1.383	1.650	1.833	1.973	2.086	2.262	2.398	2.508	2.685	2.821	2.936	3.116	3.250
10	0.260	0.542	0.879	1.372	1.634	1.812	1.948	2.058	2.228	2.359	2.465	2.634	2.764	2.872	3.043	3.169
11	0.260	0.540	0.876	1.363	1.621	1.796	1.928	2.036	2.201	2.328	2.430	2.593	2.718	2.822	2.985	3.106
12	0.259	0.539	0.873	1.356	1.610	1.782	1.912	2.017	2.179	2.303	2.402	2.560	2.681	2.782	2.939	3.055
13	0.259	0.538	0.870	1.350	1.601	1.771	1.899	2.002	2.160	2.282	2.379	2.533	2.650	2.748	2.900	3.012
14	0.258	0.537	0.868	1.345	1.593	1.761	1.887	1.989	2.145	2.264	2.359	2.510	2.624	2.720	2.868	2.977
15	0.258	0.536	0.866	1.341	1.587	1.753	1.878	1.978	2.131	2.249	2.342	2.490	2.602	2.696	2.841	2.947
16	0.258	0.535	0.865	1.337	1.581	1.746	1.869	1.968	2.120	2.235	2.327	2.473	2.583	2.675	2.817	2.921
17	0.257	0.534	0.863	1.333	1.576	1.740	1.862	1.960	2.110	2.224	2.315	2.458	2.567	2.657	2.796	2.898
18	0.257	0.534	0.862	1.330	1.572	1.734	1.855	1.953	2.101	2.214	2.303	2.445	2.552	2.641	2.778	2.878
19	0.257	0.533	0.861	1.328	1.568	1.729	1.850	1.946	2.093	2.205	2.293	2.433	2.539	2.627	2.762	2.861
20	0.257	0.533	0.860	1.325	1.564	1.725	1.844	1.940	2.086	2.197	2.285	2.423	2.528	2.614	2.748	2.845
21	0.257	0.532	0.859	1.323	1.561	1.721	1.840	1.935	2.080	2.189	2.277	2.414	2.518	2.603	2.735	2.831
22	0.256	0.532	0.858	1.321	1.558	1.717	1.835	1.930	2.074	2.183	2.269	2.405	2.508	2.593	2.724	2.819
23	0.256	0.532	0.858	1.319	1.556	1.714	1.832	1.926	2.069	2.177	2.263	2.398	2.500	2.584	2.713	2.807
24	0.256	0.531	0.857	1.318	1.553	1.711	1.828	1.922	2.064	2.172	2.257	2.391	2.492	2.575	2.704	2.797
25	0.256	0.531	0.856	1.316	1.551	1.708	1.825	1.918	2.060	2.167	2.251	2.385	2.485	2.568	2.695	2.787
26	0.256	0.531	0.856	1.315	1.549	1.706	1.822	1.915	2.056	2.162	2.246	2.379	2.479	2.561	2.687	2.779
27	0.256	0.531	0.855	1.314	1.547	1.703	1.819	1.912	2.052	2.158	2.242	2.373	2.473	2.554	2.680	2.771
28	0.256	0.530	0.855	1.313	1.546	1.701	1.817	1.909	2.048	2.154	2.237	2.368	2.467	2.548	2.673	2.763
29	0.256	0.530	0.854	1.311	1.544	1.699	1.814	1.906	2.045	2.150	2.233	2.364	2.462	2.543	2.667	2.756
30	0.256	0.530	0.854	1.310	1.543	1.697	1.812	1.904	2.042	2.147	2.230	2.360	2.457	2.537	2.661	2.750
40	0.255	0.529	0.851	1.303	1.532	1.684	1.796	1.886	2.021	2.123	2.203	2.329	2.423	2.501	2.619	2.704
50	0.255	0.528	0.849	1.299	1.526	1.676	1.787	1.875	2.009	2.109	2.188	2.311	2.403	2.479	2.594	2.678
75	0.254	0.527	0.846	1.293	1.517	1.665	1.775	1.861	1.992	2.090	2.167	2.287	2.377	2.450	2.562	2.643
100	0.254	0.526	0.845	1.290	1.513	1.660	1.769	1.855	1.984	2.081	2.157	2.276	2.364	2.436	2.547	2.626
∞	0.253	0.524	0.842	1.282	1.501	1.645	1.751	1.834	1.960	2.054	2.127	2.241	2.326	2.395	2.501	2.576

Figure 3: *t* test Distribution Table

SECTION – A

There are **FOUR** questions in this section. **Answer Question 1** and any **TWO** from the rest.

Question 1 is COMPULSORY.

1. (a) Compare the properties of the classes of problems: APX, APX-hard and APX-complete, and algorithmic paradigms: PTAS and FPTAS. Show the relationship among them. (10)
- (b) Design a PTAS for Independent Set Problem on Planar Graphs. (12)
- (c) Given a 2-regular graph G represented by a sequence of n pairs of integers between 1 and n on a read-only array as the neighbors of n vertices. Analyze the time-space trade-off in designing an algorithm which counts the number of cycles in G . (13)

2. (a) Define the k -server problem. Show that the greedy algorithm for the k -server problem is not competitive. (10)
- (b) Describe double coverage (DC) algorithm for the k -server problem and derive the competitive ratio of DC algorithm. (12)
- (c) Differentiate among an approximation algorithm, a heuristic algorithm and a meta-heuristic algorithm. How do you apply the Ant colony Method to find a maximum of a list of elements stored in an array? Explain. (3+10)

3. (a) Write the basic principle of tabu search meta-heuristic. Explain how does the length of the tabu list control the search process? What is the aspiration criteria in tabu search? (4+3+3)
- (b) Show that LP-relaxation works for finding an approximation algorithm for vertex cover problem but it does not work for finding approximation algorithm for independent set problem. (12)
- (c) Prove that no algorithm for the linear list search problem has a competitive ratio better than $2 - \frac{2}{n+1}$, where n is the number of items in the list. (13)

CSE 461

4. (a) Design a randomized algorithm for finding a minimum-cut of an undirected weighted multigraph with n vertices such that the probability of finding a minimum cut by running the algorithm $n(n-2)/2$ times is at least $1 - \frac{1}{e}$. (15)

(b) Let x_1, x_2, \dots, x_n , be the variables used in CNF formula Φ of m clauses. You choose an assignment $(\alpha_1, \alpha_2, \dots, \alpha_n) \in \{0, 1\}^n$ to (x_1, x_2, \dots, x_n) at random with $P(\alpha_i=1) = P(\alpha_i=0) = \frac{1}{2}$ for $i=1, \dots, n$. Assume that each clause has at least five literals. Compute the expected number of clauses that are satisfied. (10)

(c) For solving the online facility assignment problem. Algorithm Greedy always assign a customer to the nearest free facility. Show that the competitive ratio of Algorithm Greedy is at most $4|F|$ when the input sequence is well distributed, where F is the set of facilities. (10)

SECTION - B

There are **FOUR** questions in this section. You have to answer **THREE** questions, **INCLUDING Question 5.**

5. **[MANDATORY]**
(a) Consider the TAUTOLOGY problem that takes a Boolean expression as input and returns TRUE if and only if the expression is TRUE for every truth assignment of the concerning variables. Test for its membership in the P, NP, co-NP and PSPACE complexity classes. (12)

(b) Design a parameterized algorithm to check if a given graph $G = (V, E)$ has an independent set of size at least $|V| - k$, where k is an integer input. (12)

(c) Analyze the time complexity of the algorithm you have designed in Question 5(b) to show the corresponding problem is fixed parameter tractable. (11)

6. (a) Consider the problem TRIPLE 3-SAT that aims to find whether a given 3-CNF Boolean expression has at least three satisfying assignments of the concerning variables. Prove that this problem is NP complete. (16)

(b) Explain the "APSP-conjecture" and its implications. (8)

(c) Given a set of points in the two dimensional Euclidean plane, show that the problem of finding whether three of the given points are incident on the same line is 3SUM-hard. (11)

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7. (a) In the MINIMUM SET COVER problem, we are given a universe \mathcal{U} of elements and a collection \mathcal{S} of (non-empty) subsets of \mathcal{U} . The task is to find the minimum cardinality of a subset $\mathcal{S}' \subseteq \mathcal{S}$ which covers \mathcal{U} . Devise a dynamic programming algorithm to solve this problem exactly in $O(mn2^n)$ where $m = |\mathcal{S}|$ and $n = |\mathcal{U}|$. (16)

Hint: For every nonempty subset $U \subseteq \mathcal{U}$, and for every $j = 1, 2, \dots, m$, define $OPT[U; j]$ as the minimum cardinality of a subset of (S_1, \dots, S_j) that covers U . Then try to form a recurrence relation for $OPT[U; j+1]$.

(b) As in the hint of the Question 7(a), or in the dynamic programming formulation of the knapsack problem, we use a set of elements as an index of a DP table. Suggest an efficient way to do so in a programming language of your choice. (8)

(c) Analyze the time complexity of the following algorithm to find a maximum independent set of a given graph. (11)

```

Input: A graph  $G$ .
Output: A maximum independent set  $S$  of  $G$  and the size  $k$  of the
           maximum independent set
1  if there is no vertex in the graph then
2      $S = \emptyset$ 
3      $k = 0$ 
4     return
5  Let  $v$  be a vertex of minimum degree in  $G$ .
6  Let  $S_x$  be a maximum independent set in  $G - N[v]$  and  $k_x = |S_x|$ .
7  for every  $x \in N[v]$  do
8      $k_x = \text{maxis}(G - N[x], S_x, k_x)$ 
9   $S = \max_{x \in N[v]} \{S_x \cup \{x\}\}$ 
10  $k = 1 + \max_{x \in N[v]} k_x$ 
    
```

8. (a) Prove that the following problem (LARGEST COMMON SUBGRAPH) is NP-complete. (16)

Instance Graphs $G_1 = (V_1, E_1)$, $G_2 = (V_2, E_2)$ and an integer k .

Question Are there two isomorphic subgraphs of at least K edges in both graphs? Formally, do there exist $E'_1 \subseteq E_1$ and $E'_2 \subseteq E_2$ with $|E'_1| = |E'_2| \geq k$ such that $G'_1 = (V_1, E'_1)$ and $G'_2 = (V_2, E'_2)$ are isomorphic?

You can use reductions from CLIQUE or INDEPENDENT SET problems.

(b) Prove that if $NP \neq co-NP$, then $P \neq NP$. (8)

(c) Given a pointer to the head of a singly-linked list of n elements, devise an algorithm to determine whether it contains a cycle or not. It has to operate in $O(n)$ time and $O(1)$ extra space. (11)

SECTION – A

There are **FOUR** questions in this section. **Question No. 1 (one) is Compulsory.** In addition to answering Question 1, answer any **2** other questions.

All the questions, except for Question 1, are of equal value. Symbols have their usual meanings

1. (a) Describe with necessary examples: (15)

(i) One-hot encoding

(ii) Confusion matrix

(iii) Bias-variance tradeoff

(b) For the univariate data below, based on current parameter settings, the $p_{ij} = P(C=i|x_j)$ values have already been calculated in the **E-step** for **mixture of 2 Gaussians**. Produce the model parameter values in the **M-step**. (15)

Data Id	Feature	$P(C=1 x_j)$
x1	49	0.25
x2	53	0.50
x3	45	0.25
x4	45	0.20
x5	51	0.15

(c) You are given a dataset composed of voice recordings containing 22 biomedical features from 31 people, 23 with Parkinson's Disease (PD). For each individual, voice recordings were taken approximately 6 times. However, during recording, sometimes some biomedical features were missed. Features from each recording constitute a row in the data file. A "name" column identifies the subject from whom the data was collected. A "status" column is set to 0 for healthy and 1 for PD. All the remaining columns contain real numbers (and some missing values). In total there are 195 rows and 24 columns in the dataset. 147 of the rows are marked 1 in the status column. The main aim of the data is to discriminate healthy people from those with PD. (15)

(i) What pre-processing would you apply to this data? Elaborate.

(ii) Will you use deep learning or conventional machine learning algorithms? Explain your answer.

(iii) Will you use a separate validation set for hyper parameter tuning or use cross-validation? Argue why.

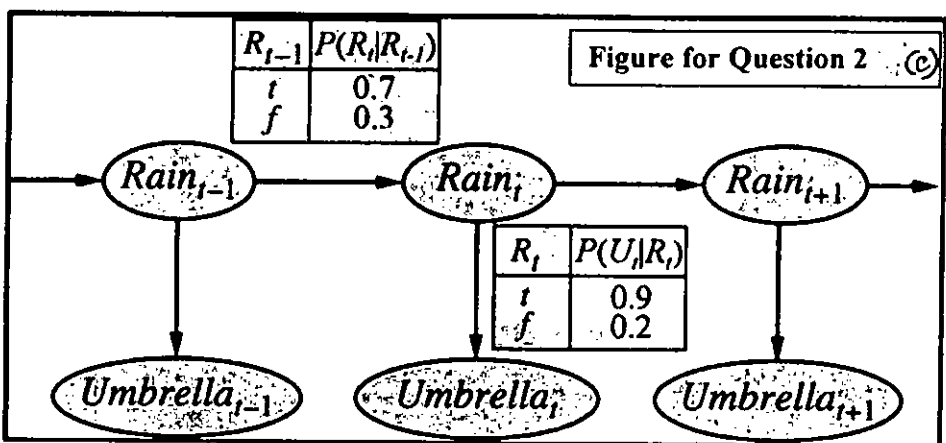
2. (a) Deduce the **normal equation** for multivariable linear regression. What is its limitation? (10)

(b) What is ensemble learning? What are its advantages? Explain boosting with necessary examples. (10)

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Contd ... Q. No. 2

(c) In the umbrella world described by the Bayesian network in the Figure for Question 2 (c), rain is the hidden variable, which needs to be inferred from the observation of umbrella. Calculate the smoothed estimate of rain probability on day 1, given umbrella observation on both day 1 and day 2. Assume a 50% chance of rain on day 0. (10)



Bayesian network structure and conditional distributions describing the umbrella world. The transition model is $P(Rain_t | Rain_{t-1})$ and the sensor model is $P(Umbrella_t | Rain_t)$.

3. (a) Describe the process of parameter estimation in Hidden Markov model. (20)

(b) Suppose you have N numbers x_1, x_2, \dots, x_N drawn from a Gaussian distribution. Recall that the Gaussian density function on a single variable is: (10)

$$P(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

This linear-Gaussian model has two parameters: mean (μ) and standard deviation (σ). Derive the maximum-likelihood estimates of these two parameters.

4. (a) For a K-class classification problem, there are K neurons in the output layer of a deep network, with outputs of f_1, f_2, \dots, f_K respectively. Then a softmax layer is added to normalize these into class probabilities p_1, p_2, \dots, p_K respectively. Cross entropy loss is used to train the model. For the i^{th} data point in the training set (x_i, y_i) , Where x_i represents the feature vector and y_i its one-hot encoded class label, state the expression for loss (L_i), Then deduce the expression for $\frac{\partial L_i}{\partial f_k}$. (10)

(b) What is a non-linear activation function? Justify its use in a deep network. Give three examples of such functions, with their definition and graphical representation. (10)

(c) Explain Adagrade optimizer with necessary equations. What are its strengths and weaknesses? Explain with necessary equations how RMSProp improves on it. (10)

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SECTION – B

There are **FOUR** questions in this section. **Question No. 5 (five) is Compulsory**. Answer Question 5 and any other **TWO** questions.

Question 5 must be answered

5. (a) Explain the four assumptions in the context of AnyNet design space which helps to explore the network architecture space effectively. (12)

(b) Modern convolutional neural networks (CNN) evolved from one architecture to another to adapt to increasingly complex application scenario. Some network pairs are mentioned below. (12)

For each network pair, illustrate the modification done to get the second network from the first, and the reason behind the change.

First Network	Second Network
AlexNet	VGG
VGG	NiN
NiN	GoogLeNet

(c) During deep neural network training, at some stage it might get difficult to understand whether an additional layer/block (increased depth) will provide additional performance boost or not. Devise a technique by which we can let the network decide whether to include that additional layer/block or not. (11)

6. (a) To train a recurrent neural network (RNN) we use BPTT (Backpropagation Through Time) algorithm. Let us consider a simple RNN without bias parameters, whose activation function in the hidden layer uses the identity mapping. The dynamics of this RNN are governed by the following equations where symbols have their usual meaning. (15)

$$h_t = W_{hx} x_t + W_{hh} h_{t-1}$$

$$o_t = W_{qh} h_t$$

Using chain rule, show that a large power of the matrix W_{hh} is responsible for vanishing/exploding gradient problem.

(b) Draw the internal gating mechanism of an LSTM cell. Write the complete mathematical formulation of LSTM memory cell update. (10+10=20)

7. (a) Both word2vec and transformer architectures produce vector embedding of a word. What is the fundamental difference between these two embeddings? (10)

(b) What is the difference in the context of latent space modeling between traditional autoencoder and variational autoencoder? How is this difference advantageous for a variational autoencoder? (10+5=15)

(c) How do the gradients propagate through the sampling layer of a variational autoencoder while executing the standard backpropagation algorithm during training? (10)

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8. (a) Assume that a 2-headed self-attention layer within the first encoder unit of a transformer has the following learned parameter matrices [all the notations have their usual meaning].

(25)

$$\begin{aligned}
 W_0^Q &= \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}, W_0^K = \begin{bmatrix} 1 & 2 & 1 \\ 2 & 1 & 2 \\ 1 & 2 & 1 \\ 2 & 1 & 1 \end{bmatrix}, W_0^V = \begin{bmatrix} 2 & 2 & 2 \\ 2 & 2 & 2 \\ 2 & 2 & 2 \\ 2 & 2 & 2 \end{bmatrix} \\
 W_1^Q &= \begin{bmatrix} 2 & 2 & 2 \\ 2 & 2 & 2 \\ 2 & 2 & 2 \\ 2 & 2 & 2 \end{bmatrix}, W_1^K = \begin{bmatrix} 2 & 1 & 2 \\ 1 & 2 & 1 \\ 2 & 1 & 2 \\ 1 & 2 & 1 \end{bmatrix}, W_1^V = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \\
 W^O &= \begin{bmatrix} 1 & 3 & 2 & 5 \\ 4 & 5 & 6 & 3 \\ 1 & 3 & 2 & 5 \\ 4 & 5 & 6 & 3 \\ 1 & 3 & 2 & 5 \\ 4 & 5 & 6 & 3 \end{bmatrix}
 \end{aligned}$$

The key-query dot-product should be normalized by dividing by 8 before passing through the Softmax layer. For the following word embedding and positional encoding matrices, calculate the output encoding of the self-attention layer. Show all the intermediate calculations and results.

$$X = \begin{bmatrix} 1 & 3 & 2 & 5 \\ 4 & 5 & 6 & 3 \end{bmatrix}, P = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 2 & 2 & 2 & 2 \end{bmatrix}$$

- (b) Why do we use multi-head attention in the transformer architecture?

(10)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2021-2022

Sub: **HUM 473** (Financial Cost and Managerial Accounting)

Full Marks: 140

Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – AThere are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) What is the normal balance for each of the following accounts (Debit or, Credit)? (7)
 (i) Accounts Receivable, (ii) Cash, (iii) Owner's Drawing, (iv) Accounts Payable,
 (v) Service Revenue, (vi) Salaries Expenses, (vii) Owner's Capital.
 (b) On April 1, Holly Palmer established Matrix Travel Agency. The following transactions were completed during the month. (16 $\frac{1}{3}$)
- April 1. Invested Tk. 10,000 cash to start agency
 2. Paid Tk. 400 cash for April office rent.
 3. Purchased office equipment for Tk. 2,500 cash.
 4. Incurred Tk. 300 of advertising costs in the Chicago Tribune, on account.
 5. Paid Tk. 600 cash for office supplies.
 6. Earned Tk. 7,500 for services rendered: Tk. 1,000 cash is received from customers, and the balance of Tk. 6,500 is billed to customers on account.
 7. Withdrew Tk. 200 cash for personal use.
 8. Paid Chicago Tribune amount due on April 4.
 9. Paid employees' salaries Tk. 2,200.
 10. Received Tk. 5,000 in cash form customers who have previously been billed on April-6.
- Instructions:** Prepare a tabular analysis of the transactions using the following headings: Cash, Accounts Receivable, Supplies, Office Equipment, Accounts Payable, and Holy Palmer Capital.
2. (a) Write down the basic accounting equation with brief description. (5)
 (b) Mark Mille started his own delivery services, Miller Deliveries, on June 1, 2023. The following transactions occurred during the month of June. (18 $\frac{1}{3}$)
- June 1. Mark invested Tk. 10,000 cash in the business
 June 2. Purchased a used van for deliveries for Tk. 12,000. Mark paid Tk. 2,000 cash and signed a note payable for the remaining balance.
 June 3. Paid Tk. 500 for office rent for the month.
 June 5. Performed Tk. 4,000 of service on account.
 June 9. Withdrew Tk. 200 cash for personal use.
 June 12. Purchased supplies for Tk. 150 on account.
 June 15. Received a Cash payment of Tk. 1,250 for services provided on June 5
 June 17. Purchased gasoline for Tk. 100 on account
 June 20. Received a cash payment of Tk. 1,500 for services provided
 June 23. Made a cash payment of Tk. 500 on the notes payable
 June 26. Paid Tk. 250 for utilities
 June 29. Paid for the gasoline purchased on account on June 17
 June 30. Paid Tk. 1,000 for employees' salaries

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Contd ... Q. No. 2(b)

Required:

- (i) Journalized each transaction.
 - (ii) Post the journal to the following ledger accounts:
 (a) Cash; (b) Service Revenue; (c) Supplies
3. (a) Define Asset, Liability, Owner's Equity, Revenue and Expenses. (5)
- (b) Tony Masasi started his own consulting firm, Masasi Company, on June 1, 2023. The trial balance on June 30 is shown below (18 1/3)

Masasi COMPANY
 Trial Balance June 30, 2023

Accounts	Debit (Tk)	Credit (Tk)
Cash	8000	
Accounts Receivable	6000	
Supplies	2000	
Prepaid Insurance	3000	
Equipment	15000	
Accounts Payable		4500
Unearned Service Revenue		4000
Owner's Capital		22600
Service Revenue		7900
Salaries and Wages Expense	4000	
Rent Expense	1000	
Total	<u>39000</u>	<u>39000</u>

In addition to those accounts listed on the trial balance, the chart of accounts for Masasi Company also contains the following accounts and account: Accumulated Depreciation Equipment, Salaries and Wages Payable, Supplies Expense, Depreciation Expense, Insurance Expense, and Utilities expense

Other data:

- (i) Supplies on hand at June 30 are tk 750.
- (ii) A utility bill for tk 150 has not been recorded and will not be paid until next month.
- (iii) The insurance policy is for a year.
- (iv) Tk. 2,800 of unearned service revenue has been earned at the end of the month.
- (v) Salaries of tk 1,900 are accrued at June 30.
- (vi) The equipment has a 5-year life with no salvage value. It is being depreciated at tk. 250 per month for 60 months.
- (vii) Invoices representing tk 1,200 of services performed during the month have not been recorded as of June 30.

Requirements:

- (a) Prepare the adjusting entries for the month of June.
- (b) Prepare an adjusted trial balance at June 30, 2023

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4. (a) What are the common properties of a business transaction? (5)
 (b) Mark Mille started his own delivery services, Miller Deliveries, on June 1, 2023. The following transactions occurred during the month of June. (18 1/3)

- June 1. Mark invested Tk. 10,000 cash in the business.
- June 2. Purchased a used van for deliveries for Tk. 12,000. Mark paid Tk. 2,000 cash and signed a note payable for the remaining balance.
- June 3. Paid Tk. 500 for office rent for the month.
- June 5. Performed Tk. 4,000 of service on account.
- June 9. Withdrew Tk. 200 cash for personal use.
- June 12. Purchased supplies for Tk. 150 on account.
- June 15. Received a Cash payment of Tk. 1,250 for services provided on June 5.
- June 17. Purchased gasoline for Tk. 100 on account
- June 20. Received a cash payment of Tk. 1,500 for services provided
- June 23. made a cash payment of Tk. 500 on the notes payable
- June 26. Paid Tk. 250 for utilities
- June 29. Paid for the gasoline purchased on account on June 17
- June 30. Paid Tk. 1,000 for employees' salaries

Instructions:

- (i) Determine amount in each column of extended accounting equation (Assets, Liabilities and Owner's Equity)

Date	Assets				=	Liabilities		+	Owner's Equity
	Cash	Accounts Receivable	Supplies	Delivery Van		Notes Payable	Accounts Payable		M. Miller Capital

- (ii) Prepare an income statement for the month ended June
 (iii) Prepare a Balance Sheet for June 30, 2023

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) What are the three major elements of product costs in a manufacturing company? Briefly explain. (6)
 (b) Selected account balances for the year ended December 31 are provided below for Superior Company: (17 1/3)

Selling and administrative salaries	Tk. 110,000
Insurance, factory	Tk. 8,000
Utilities, factory	Tk. 45,000
Purchases of raw materials	Tk. 290,000
Indirect labor	Tk. 60,000
Direct labor	?
Advertising expense	Tk. 80,000
Cleaning supplies, factory	Tk. 7,000
Sales commissions	Tk. 50,000
Rent, factory building	Tk. 120,000
Maintenance, factory	Tk. 30,000

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Contd ... Q. No. 5(b)

Inventory balances at the beginning and end of the year were as follows:

	Beginning of the Year	End of the Year
Raw materials	Tk. 40,000	Tk. 10,000
Work in process	?	Tk. 35,000
Finished goods	Tk. 50,000	?

The total manufacturing costs for the year were Tk. 683,000; the goods available for sale totaled Tk. 740,000; and the cost of goods sold totaled Tk. 660,000.

Required: Prepare a schedule of cost of goods manufactured and the cost of goods sold section of the company's income statement for the year.

6. (a) Cycle Gear Corporation has incurred the following costs on job number W456, an order for 20 special sprockets to be delivered at the end of next month. (8)

Direct materials:

On April 10, requisition number 15673 was issued for 20 titanium blanks to be used in the special order. The blanks cost Tk. 15.00 each.

On April 11, requisition number 15678 was issued for 480 hardened nibs also to be used in the special order. The nibs cost Tk. 1.25 each.

Direct labour:

On April 12, Jamie Unser worked from 11:00 AM until 2:45 PM on Job W456. He is paid Tk. 9.60 per hour.

On April 18, Melissa Chan worked from 8:15 AM until 11:30 AM on Job W456. She is paid Tk. 12.20 per hour.

Required:

- (i) On what documents would these costs be recorded?
- (ii) How much cost should have been recorded on each of the documents for Job W456?
- (b) Minden Company introduced a new product last year for which it is trying to find an optimal selling price. Marketing studies suggest that the company can increase sales by 5,000 units for each Tk. 2 reduction in the selling price. The company's present selling price is Tk. 70 per unit, and variable expenses are Tk. 40 per unit. Fixed expenses are Tk. 540,000 per year. The present annual sales volume (at the Tk. 70 selling price) is 15,000 units. (15 1/3)

Required:

- (i) What is the present yearly net operating income or loss?
- (ii) What is the present break-even point in units and in dollar sales?
- (iii) Assuming that the marketing studies are correct, what is the *maximum* profit that the company can earn yearly? At how many units and at what selling price per unit would the company generate this profit?
- (iv) What would be the break-even point in units and in sales dollars using the selling price you determined in (iii) above (e.g., the selling price at the level of maximum profits)? Why is this break-even point different from the break-even point you computed in (ii) above?

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7. (a) Jorgansen Lighting, Inc., manufactures heavy-duty street lighting systems for municipalities. The company uses variable costing for internal management reports and absorption costing for external reports to shareholders, creditors, and the government. The company has provided the following data:

(10)

	Year 1	Year 2	Year 3
Inventories:			
Beginning (units)	200	170	180
Ending (units)	170	180	220
Variable costing net operating income	Tk. 1,080,400	Tk. 1,032,400	Tk. 996,400

The company's fixed manufacturing overhead per unit was constant at Tk. 560 for all three years.

Required:

- (i) Determine each year's absorption costing net operating income.
 - (ii) In Year 4, the company's variable costing net operating income was Tk. 984,400 and its absorption costing net operating income was Tk. 1,012,400. Did inventories increase or decrease during Year 4? How much fixed manufacturing overhead cost was deferred or released from inventory during Year 4?
- (b) Briarcliff Stove Company is considering a new product line to supplement its range line. It is anticipated that the new product line will involve cash investment of Tk. 700,000 at time 0 and Tk. 1.0 million in year 1. After-tax cash inflows of Tk. 250,000 are expected in year 2, Tk. 300,000 in year 3, Tk. 350,000 in year 4, and Tk. 400,000 each year thereafter through year 10. Though the product line might be viable after year 10, the company prefers to be conservative and end all calculations at that time.

(13 1/3)

Required:

- (i) If the required rate of return is 15 percent, what is the net present value of the project? Is it acceptable?
 - (ii) What is its internal rate of return?
 - (iii) What is the project's payback period?
8. (a) What is working capital? Briefly explain significance of working capital management.
- (b) Bed & Bath, a retailing company, has two departments, Hardware and Linens. A recent monthly contribution format income statement for the company follows:

(8)

(15 1/3)

	Total	Department	
		Hardware	Linens
Sales	Tk. 4,000,000	Tk. 3,000,000	Tk. 1,000,000
Less variable expenses	1,300,000	900,000	400,000
Contribution margin	2,700,000	2,100,000	600,000
Less fixed expenses	2,200,000	1,400,000	800,000
Net operating income (loss)	Tk. 500,000	Tk. 700,000	Tk. (200,000)

A study indicates that Tk. 340,000 of the fixed expenses being charged to Linens are sunk costs or allocated costs that will continue even if the Linens Department is dropped. In addition, the elimination of the Linens Department will result in a 10% decrease in the sales of the Hardware Department.

Required: If the Linens Department is dropped, what will be the effect on the net operating income of the company as a whole?

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2021-2022

Sub: **IPE 493 (Industrial Management)**

Full Marks: 210

Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – AThere are **FOUR** questions in this section. Answer any **THREE** Questions.

1. (a) How can the choice of facility layout impact the efficiency and productivity of a manufacturing plant, and what factors should be considered when designing an optimal layout for a new facility? (8)

- (b) An assembly line is to be designed to operate $7 \frac{1}{2}$ hours per day and supply a steady demand of 300 units per day. Here are the tasks and their performance times: (18)

Task	Preceding Tasks	Performance Time (Seconds)
a	-	70
b	-	40
c	-	45
d	a	10
e	b	30
f	c	20
g	d	60
h	e	50
i	f	15
j	g	25
k	h, i	20
l	j, k	25

- Draw the precedence diagram.
- What is the workstation cycle time required to produce 300 units per day?
- What is the theoretical minimum number of workstations?
- Assign tasks to workstations using the longest operating time?
- What is the efficiency of your line balance, assuming it is running at the cycle time from part (ii)?

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vi. Suppose demand increases by 10 percent. How would you react to this? Assume you can operate only $7 \frac{1}{2}$ hours per day.

(c) What are the pros and cons of relocating a small or mid-sized manufacturing firm (that makes household appliances) from the United States to China? (9)

2. (a) Which characteristics must a project have for critical path scheduling to be applicable? Explain the significance of determining the critical path of a project. (6+6=12)

(b) A Construction project is broken down into the following 13 activities: (23)

Activity	Immediate predecessor	Time (weeks)
A	-	4
B	-	6
C	A	4
D	B	3
E	A, B	5
F	C, D	6
G	C, D	2
H	E, F	3
I	E, G	5
J	H	7
K	I	4
L	J, K	5
M	J, K	6

i. Draw the network diagram and find the project duration.

ii. Determine the critical path.

iii. Which activities have slack and how much?

3. (a) Let's say you work for a company that makes prepared breakfast cereals like cornflakes. Your company is planning to introduce a new hot breakfast product made from whole grains that would require some minimal preparation by the consumer. This would be a completely new product for the company. How would you propose forecasting initial demand for this product? (8)

(b) Sales for twelve quarters of the year 2021 to 2023 are given below. Predict the sales for each quarter of the year 2024 using the appropriate method. (23)

Year 2021	Sales	Year 2022	Sales	Year 2023	Sales
1 st Quarter	800	1 st Quarter	1990	1 st Quarter	3300
2 nd Quarter	880	2 nd Quarter	1920	2 nd Quarter	3560
3 rd Quarter	1090	3 rd Quarter	2190	3 rd Quarter	3690
4 th Quarter	1740	4 th Quarter	3060	4 th Quarter	4750

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- 4. (a) Describe the two-factor theory and Expectancy theory of motivation. (10)
- (b) Write short notes on trait, behavioral, and contingency approaches of leadership. (10)
- (c) What are the main theories of management? Briefly describe various functions of management. (15)

SECTION – B

There are FOUR questions in this section. Answer any THREE Questions.

- 5. (a) Differentiate "Power" and "Authority". What are the five bases of "Power". (10)
- (b) What is organizational structure? Describe different types of divisional organizational structures with examples. (10)
- (c) Why is workplace conflict important? How to manage "conflict" in the Workplace? (15)

- 6. (a) What are the most common management skills? How the relative importance of these skills varies according to the management level within the organization? (10)
- (b) Briefly describe performance appraisal method. What are the benefits of performance appraisal? (10)
- (c) From the following data, calculate the earnings of each worker under Halsey plan, Halsey-Weir plan and Rowan plan. (15)

Workers	Worker P	Worker Q
Time allowed (hours).....	8	6
Time taken (hours).....	6	3
Hourly rate (taka).....	100	120

- 7. (a) Explain various types of quality costs with examples. (10)
- (b) ELM skateboards INC is now producing the heavy duty bearing that is used in its most popular line of skateboards. The company's accounting department reports the following costs of producing eight thousand units of the bearings internally each year: (10)

	<u>Per unit</u>	<u>8000 units</u>
Direct Materials.....	\$ 6	\$ 48,000
Direct Labor.....	\$ 4	\$ 32,000
Variable Overhead.....	\$ 1	\$ 8,000
Supervisor salary.....	\$ 3	\$ 24,000
Depreciation of special equipment....	\$ 2	\$ 16,000
<u>Allocated general overhead.....</u>	<u>\$ 5</u>	<u>\$ 40,000</u>
Total cost	<u>\$ 21</u>	<u>\$ 168,000</u>

An Outside supplier offered to sell 8000 bearings to ELM at a price of only nineteen dollars each. Should the company stop producing the bearing internally and buy them from the outside supplier?

IPE 493/CSE

(c) XYZ company makes prestige high-end custom watches in small lots. One of the company's products a platinum diving watch, goes through an etching process. The company has observed etching costs (expressed in Swiss Francs, SFr) as follows over the last six weeks.

(15)

Week	Units	Total Etching Cost (SFr)
1.....	4	18
2.....	3	17
3.....	8	25
4.....	6	20
5.....	7	24
6.....	2	16
	30	120

For planning purposes, management would like to know the amount of variable etching cost per unit and the total fixed etching cost per week.

Required:

- i. Using the least -squares regression method, estimate variable and fixed elements of etching cost.
- ii. Express the cost data in (i) above in the form $Y = a + bX$.
- iii. If the company processes five units next week, what would be the expected total etching cost?

8. (a) According to Henry Mintzberg, what roles do managers play within an organization?

(10)

(b) Data for Hermann Corporation are shown below:

(10)

	<u>Per Unit</u>	<u>Percent of Sales</u>
Selling Price.....	\$148	100%
Variable expenses.....	\$91	65%
Contribution margin....	\$49	35%

Fixed expenses are \$88,000 per month and the company is selling 3,000 units per month.

- i. How much will net operating income increase (decrease) per month if the monthly advertising budget increases by \$9,300 and monthly sales increase by \$21,500?
- ii. Should the advertising budget be increased?

IPE 493/CSE

(c) Perit Industries has \$300,000 to invest. The company is trying to decide between two alternative uses of the funds. The alternatives are:

(15)

	<u>Project A</u>	<u>Project B</u>
Cost of equipment required	\$300,000	\$0
Working capital investment required	\$0	\$300,000
Annual cash inflows	\$80,000	\$60,000
Salvage value of equipment in seven years	\$20,000	\$0
Life of the project	7 years	7 years

The working capital needed for project B will be released at the end of seven years for investment elsewhere. Perit Industries' discount rate is 20%.

Which investment alternative (if either) would you recommend that the company accept? Show all computation using the net present value format. Prepare separate computations for each project.
