

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY  
 B.Sc. Engineering 2<sup>nd</sup> Year 2<sup>nd</sup> Term Examination, 2022  
 Department of Computer Science and Engineering  
 CSE 2201

Algorithm Analysis and Design

TIME: 3 hours

FULL MARKS: 210

- N.B. i) Answer **ANY THREE** questions from each section in separate scripts.  
 ii) Figures in the immediate right column of the questions indicate full marks.  
 iii) The rightmost column indicates course outcomes.

**SECTION A**

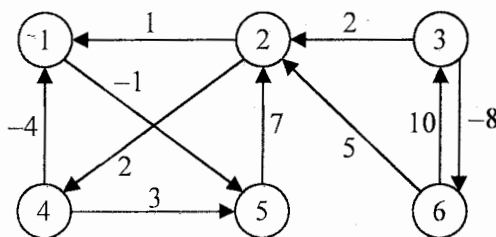
(Answer **ANY THREE** questions from this section in Script A)

1. a) What is an algorithm? What are the basic criteria that an algorithm must satisfy? (08) [CO1]
- b) Design an efficient algorithm (in terms of asymptotic complexity in the worst case) to determine if two students in a class of  $n$  students have the same height. What is the complexity of your algorithm? Consider the following two cases: (10) [CO2]
  - (i) The smallest measure is centimeter.
  - (ii) There is no such limit (i.e., each measure is precise).
- c) What is time complexity? How to calculate time complexity? What is the running time in  $\theta$  - notation (as a function of  $n$ ) of the following code? Give an explanation. (10) [CO1]

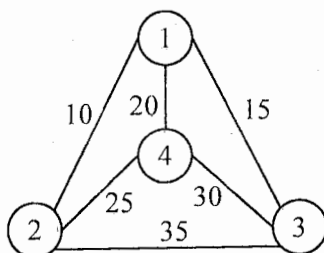
```

for x = 1 to n do
  begin
    y = x;
    while y > 1 do
      y = y/2;
    end
  
```

- d) What are the differences between performance analysis and performance measurement of an algorithm? (07) [CO1]
2. a) Consider the fractional knapsack problem: "Given  $n$  items with values and weights and a knapsack with capacity  $C$ . You may take fractions of each item and as many of each item as you want. Find the selection of items that maximizes the possible value that can fit in your knapsack". Describe an efficient greedy strategy for this problem and prove that your greedy choice strategy works. (10) [CO2]
  - b) Consider a sum of subset problem with 6 items ( $n = 6$ ) and  $\text{sum}(m) = 30$ . The items are  $w[1:6] = \{5, 10, 12, 13, 15, 18\}$ . Now draw a state space tree for the above problem using backtracking approach. (10) [CO2]
  - c) Apply the Floyd-Warshall algorithm on the weighted directed graph shown in the following figure. Show the matrix (all pair)  $D^k$  that results for each iteration of the outer loop. (10) [CO3]



- d) Derive the relationship between backtracking technique and recursive technique. (05) [CO1]
3. a) Consider the following Travelling Salesman Problem (TSP): (13) [CO3]

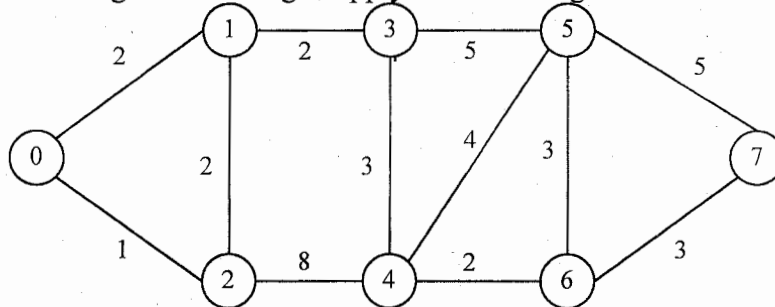


- (i) Convert it to a multi-stage graph.
- (ii) Find the minimum cost path in the multi-stage graph (From(i)). Do this using the forward approach.

- b) Derive the explicit and implicit constraints for Sum of Subset problem. Apply these (09) [CO2] constraints and then write down the backtracking algorithm to solve it.
- c) Consider the following table. Construct optimal binary search tree (OBST) for keys (13) [CO2] with the given probabilities.

$k$	1	2	3	4	5
$p(k)$	0.22	0.24	0.25	0.28	0.01

4. a) What is spanning tree? Consider the following undirected graph where the value of each (11) [CO1] edge represents the length of that edge. Apply Kruskal's algorithm.



- (i) What is the length of the shortest path between 0 and 7.  
(ii) What is the total length of the edges in a minimum spanning tree?

- b) Consider the following cost matrix. Find the optimal solution of TSP using branch and (14) [CO2] bound method.

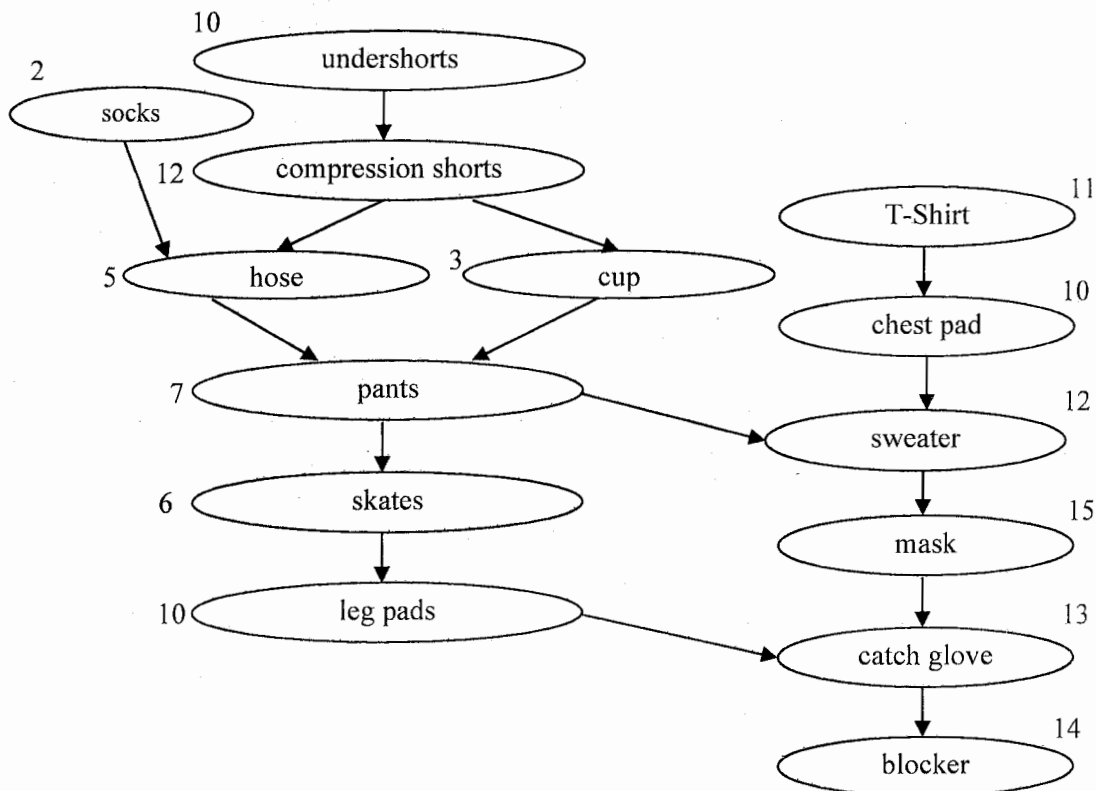
$$\text{Cost Matrix} = \begin{bmatrix} - & 20 & 30 & 10 & 11 \\ 15 & - & 16 & 4 & 2 \\ 3 & 5 & - & 2 & 4 \\ 19 & 6 & 18 & - & 3 \\ 16 & 4 & 7 & 16 & - \end{bmatrix}$$

- c) How can you test whether two queens are in the same diagonal or not? Apply (10) [CO2] backtracking method to solve 4-queen problem.

### SECTION B

(Answer ANY THREE questions from this section in Script B)

5. a) Define the edge and forward edge. What is the difference between them? Illustrate with (08) [CO2] an example.
- b) Consider the following DAG (for equipping a sportsman) where the number next to the (27) [CO2] vertex indicates the required time for performing the task corresponding to the vertex.



Now,

- (i) Find the valid order of putting the equipments using the proper algorithm.  
(ii) Find the minimum required time for getting him ready if the sportsman can perform parallel tasks by designing proper algorithm.

6. a) Let  $f(n) = 2^{n+1}$  and  $g(n) = 2^n$ . Prove that  $f(n) = O(g(n))$ . (11) [CO1]  
 b) Identify the limitation of Ford-Fulkerson algorithm. How can it be resolved? (12) [CO2]  
 Demonstrate with proper illustration.  
 c) Construct a hash table using the hash function,  $h(k) = 2k \bmod 11$  by considering the following key-value pairs. If there is a collision, use  $h_1(k) = 5 - (k \bmod 5)$  hash function to resolve this. (12) [CO2]

key	18	41	22	44	32	73	59	30	100	31
value	10	20	30	40	60	80	50	100	90	70

7. a) Define absolute and  $\epsilon$ -approximation algorithms. Consider the following instance of a 0/1 knapsack problem:  $n = 2$ ,  $(p_1, p_2) = (2, r)$ ,  $(w_1, w_2) = (1, r)$  and  $M = r$ . Can you find any absolute and  $\epsilon$ -approximate algorithm of this problem where  $r > 1$  and  $\epsilon < 1$ . (14) [CO3]  
 b) Develop a non-deterministic polynomial time algorithm for sorting a list of numbers. Also, find the time complexity of it. (10) [CO3]  
 c) How does the network flow problem help you to solve the maximum bipartite matching problem? Illustrate with an example. (11) [CO2]
8. a) Develop a Gantt chart of the following jobs using job shop scheduling and answer the following questions: (18) [CO4]

Job0 = [(0, 3), (1, 2), (2, 2)] & Due date = 5  
 Job1 = [(0, 2), (2, 1), (1, 4)] & Due date = 7  
 Job2 = [(1, 4), (2, 3)] & Due date = 4

Here, each job has multiple tasks to complete. For Job0, there are 3 tasks. The first (0, 3) task must be processed on machine 0 in 3 units of time. The second (1, 2) task must be processed on machine 1 in 2 units of time and so on. Determine the followings:

- (i) Makespan.
  - (ii) Total completion time.
  - (iii) Total tardiness.
  - (iv) The utilization of the machines.
- [N.B. Use the longest processing time (LPT) as the dispatching rule for further tie - breaking apply any rule of your choice].
- b) Prove the equality between the minimum cut capacity and the maximum flow value in a flow network with proper example. (10) [CO1]  
 c) Consider  $F = (x_1 \vee x_2 \vee x_3) \wedge (\bar{x}_1 \vee \bar{x}_2 \vee \bar{x}_3)$ , be a propositional formula in conjunctive normal form (CNF). Prove that CNF - satisfiability (SAT)  $\propto$  clique decision problem (CDP). (07) [CO2]

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B.Sc. Engineering 2<sup>nd</sup> Year 2<sup>nd</sup> Term Examination, 2022  
Department of Computer Science and Engineering  
CSE 2203

Microprocessors and Microcontrollers

TIME: 3 hours

FULL MARKS: 210

- N.B. i) Answer **ANY THREE** questions from each section in separate scripts.  
ii) Figures in the immediate right column of the questions indicate full marks.  
iii) The rightmost column indicates course outcomes.

**SECTION A**

(Answer **ANY THREE** questions from this section in Script A)

1. a) If a microprocessor is defined as n-bit microprocessor then describe what is meant by n. (06) [CO1]  
b) What is pipelining in 8086 microprocessor? (06) [CO1]  
c) Design a traffic light controlling system using a microcontroller. Show the hardware and software design in detail. (11) [CO3]  
d) What are the addressing modes of 8086? Determine and explain (in brief) the addressing modes of the following instructions: (i) MOV AL, 04H, (ii) MOV AX, [6000H], (iii) MOV AX, [SI], (iv) MOV AX, 50H [BX]. (12) [CO1]
2. a) What is Reentrant Procedure? Mention the conditions that are crucial for a procedure to be reentrant. (07) [CO4]  
b) Show the stack mapping for the following instructions: (07) [CO4]

```
MULTO PROC NEAR  
PUSH F  
PUSH AX  
PUSH BX  
PUSH CX  
.  
.  
.  
POP CX  
POP BX  
POP AX  
POPF  
RET  
MULTO ENDP
```

  
c) How does priority resolver handle the situation when 8086  $\mu$ p is executing the IR<sub>4</sub> service procedure meanwhile an interrupt signal arrives at IR<sub>2</sub> input of 8259A. (09) [CO2]  
d) Construct the binary code (showing template for each one) of the following instructions: (i) MOV CS: [BX], DL, (ii) MOV CX, [413EH], (iii) ADD AL, 07H, (iv) IN AL, 05H. (12) [CO4]
3. a) Define Interrupt, and Interrupt Pointer Table. At what addresses are CS<sub>50</sub> and IP<sub>50</sub> stored in memory? (12) [CO1]  
b) Show and illustrate two examples where Divide-by-Zero interrupt occur. (06) [CO2]  
c) Write the instructions that can be used to set and reset the trap flag. (06) [CO4]  
d) What is the difference between conditional jump and unconditional jump? Illustrate your answer using assembly language instructions. (11) [CO4]
4. a) Compare the following instructions with proper examples: (i) ROL and ROR, (ii) REP and LOOP. (08) [CO4]  
b) What is Direct Memory Access (DMA) data transfer? Describe DMA data transfer techniques with neat sketch. (11) [CO2]  
c) What is the key idea to control the speed of a dc motor using a microcontroller? Explain with a neat sketch. (08) [CO3]  
d) Consider the following table where different instructions and corresponding required cycles are shown. (08) [CO4]

Instrutions	Required cycles
MOV BX, N1	4
THERE: MOV CX, N2	4
HERE: LOOP HERE	17/5
DEC BX	2
JN2 THERE	16/4

If the system has a clock of 12 MHz, and N2=FFFFH then find the value of N1 for a delay of 1 second.

### SECTION B

(Answer ANY THREE questions from this section in Script B)

5. a) Differentiate between microprocessors and microcontrollers. (06) [CO1]  
 b) Suppose you want to build a system using a microcontroller. Depict how the proper microcontroller can be chosen. (07) [CO3]  
 c) Consider the register of 8051 microcontroller as shown below: (10) [CO2]

SM0	SM1	SM2	REN	TB8	RB8	TI	RI
-----	-----	-----	-----	-----	-----	----	----

What is the name of the register? Describe the functions of each bit of the registers in brief.

- d) Illustrate the resulting contents of 8051  $\mu$ c register bank after executing the following instructions: (12) [CO4]

```
MOV R1, #02h
MOV R3, #04H
PUSH 1
MOV PSW, #12H
POP 3
MOV PSW, #84H
PUSH 3
```

6. a) If a microcomputer has a 24 bit address bus, then measure the maximum physical memory size of it without any virtualization. (06) [CO1]  
 b) Describe the operation of 8254 PIT when, (i) '0DEh' is loaded into Control Word Register, (ii) '40h' is loaded into Control Word Register, (iii) CW='10h', D<sub>0</sub>-D<sub>7</sub>= '04h' and GATE=1. (12) [CO2]  
 c) Suppose interrupts INT0, TF0, and INT1 are activated at the same time. Upon reset, registers Interrupt Enable (IE) is set to '0DH' and Interrupt Priority (IP) is set to '06h'. Now examine the sequence in which the 8051  $\mu$ c will service these interrupts. IE and IP formats are given below: (12) [CO3]

IE	EA	-	ET2	ES	ET1	EX1	ET0	EX0
IP	-	-	PT2	PS	PT1	PX1	PT0	PX0

- d) Describe the salient features of 8051  $\mu$ c in brief. (05) [CO3]

7. a) State the two methods with appropriate figure(s) that can be used to solve the limited memory problem other than MMU. (12) [CO1]  
 b) Identify the value of signals A<sub>0</sub>,  $\overline{\text{BHE}}$ , D<sub>0</sub>-D<sub>7</sub>, D<sub>8</sub>-D<sub>15</sub>, memory banks and location accessed for the following transfer operations: (i) A byte '03H' is written in location 2000:3001H, (ii) A word '0FE1H' is written in location 2000:0008H. (08) [CO1]  
 c) How can tasks be isolated in multitasking enabled processor like 80386? (07) [CO2]  
 d) Explain how demand segmentation can extend the address space accessible by an 80286 from 16MB to 1GB? (08) [CO3]

8. a) Suppose an LED is connected to p3.4 of 8051 microcontroller. The LED turns on when Timer 0 counts to zero. Crystal oscillator of 8051 has a frequency of 11Mhz. Now, program the microcontroller to turn the LED on after 3 seconds. (12) [CO3]  
 b) Explain the conditions with representative data type values of 8087 stack after performing the following operations sequentially: (i) After reset, (ii) PUSH 9.75 (Single precision), (iii) PUSH -4.75 (Double extended precision), (iv) PUSH 9.75 (Single precision), (v) POP 2 elements. (13) [CO2]  
 c) Suppose interrupts INT0, TF0 and INT1 of 8051  $\mu$ c are activated at the same time. Assume that after reset the interrupt priority is set by the instruction "MOV IP, #00001100B". Discuss the sequence in which the interrupts are serviced after setting this value of IP register of 8051  $\mu$ c. (10) [CO3]

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 CSE 2207

Numerical Methods

TIME: 3 hours

FULL MARKS: 210

- N.B. i) Answer **ANY THREE** questions from each section in separate scripts.  
 ii) Figures in the immediate right column of the questions indicate full marks.  
 iii) The rightmost column indicates course outcomes.

**SECTION A**

(Answer **ANY THREE** questions from this section in Script A)

1. a) What do you mean by quadrature? Explain with example. (10) [CO1]  
 b) Derive a general quadrature formula for equidistant ordinates and from this derive the formula for Simpson's  $\frac{3}{8}$  rule. (11) [CO2]  
 c) Integrate  $\int_4^{5.2} \tan x \, dx$  by Simpson's  $\frac{1}{3}$  rule. Compare the result with the standard value. (14) [CO2]
  
2. a) What do you mean by boundary or initial condition? Illustrate it with respect to a ordinary differential equation. (10) [CO1]  
 b) Describe the basic difference between Euler's method and modified Euler's method. (12) [CO2]  
 c) Use Runge-Kutta quadratic method to calculate three additional points on the solution curve of the problem,  $\frac{dy}{dx} = 1 - 2xy$ ,  $y(0) = 0$ ,  $h = 0.1$ . (13) [CO4]
  
3. a) Find the inverse of  $A = \begin{bmatrix} 2 & -2 & 4 \\ 2 & 3 & 2 \\ -1 & 1 & -1 \end{bmatrix}$  by Gauss-Jordon method. (12) [CO1]  
 b) Suppose a matrix  $A$  will be factorized into  $L$  and  $U$  as follows:  $A = LU$ . Then find the equation for  $L$  and  $U$ . (11) [CO3]  
 c) Solve the following system by Cramer's rule: (12) [CO3]
 
$$\begin{aligned} 2x + 3y + z &= 9 \\ x + 2y + 3z &= 6 \\ 3x + y + 2z &= 8 \end{aligned}$$
  
4. a) What do you mean by partial differential equations? And write the general form of second-order equation involving two independent variables. (12) [CO1]  
 b) Derive the five-point formula for Laplace's equation. (13) [CO2]  
 c) Consider a steel plate of size 18cm×18cm. If two of the sides are held at 100°C and the other two sides are held at 0°C, what are the steady-state temperature at interior points assuming a grid size of 6 cm × 6 cm. (10) [CO4]

**SECTION B**

(Answer **ANY THREE** questions from this section in Script B)

5. a) Demonstrate the search interval, starting and stopping criteria of an iterative process. What are the limitations of Bisection method? (10) [CO2]  
 b) Comprehend error propagation for  $w = yz^2 + xy^3$ . Explain the dependence of error on step size. (10) [CO3]  
 c) Estimate the value of  $f(x)$  for  $x = 2.5$  using both linear and Lagrange interpolation for the given tabular value and compare the results. (15) [CO4]

$x$	1	2	3	4	5
$f(x)$	1	1.4142	1.7321	2	2.2361

6. a) Describe the differences between interpolation and regression. (08) [CO1]  
 b) Demonstrate the value of  $f(\theta)$  for  $\theta = 25^\circ$  using Newton-Gregory backward difference formula from the given table. (12) [CO4]

$\theta$	10	20	30	40	50
$f(\theta)$	0.1736	0.3420	0.5000	0.6428	0.7660

- c) Given  $\sin 45^\circ = 0.7071$ ,  $\sin 50^\circ = 0.7660$ ,  $\sin 55^\circ = 0.8191$ ,  $\sin 60^\circ = 0.8660$ . Find  $\sin 52^\circ$  by using any method of interpolation. (15) [CO3]

7. a) Discuss about the changing of convergence rate according to the iterations and relative error. (05) [CO1]
- b) Demonstrate Newton-Raphson method to find out the roots and find a real root of the equation,  $-4x + \cos x + 2 = 0$ , assuming  $x_0 = 0.5$ . (18) [CO4]
- c) Formulate eigen value and eigen vector using power method from the following equations. (12) [CO3]

$$\begin{aligned}(-1 - \lambda)x_1 &= 0 \\ x_1 + (-2 - \lambda)x_2 + 3x_3 &= 0 \\ 2x_2 + (-3 - \lambda)x_3 &= 0\end{aligned}$$

8. a) Discuss the limitations of Newton-Raphson method and the solutions of them. Explain how secant method is different from false position method. (10) [CO1]
- b) Use Faddeev's method to find the characteristic polynomial of the matrix. (15) [CO3]

$$A = \begin{bmatrix} 2 & -1 & 1 \\ -1 & 2 & 1 \\ 1 & -1 & 2 \end{bmatrix}$$

- c) Find a regression plane for the following given data set: (10) [CO2]

$x$	1	2	3	4	5
$z$	0	1	2	3	4
$y$	12	18	24	30	36

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY  
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Department of Computer Science and Engineering  
HUM 2207

Economics and Accounting

TIME: 3 hours

FULL MARKS: 210

- N.B. i) Answer **ANY THREE** questions from each section in separate scripts.  
ii) Figures in the immediate right column of the questions indicate full marks.  
iii) The rightmost column indicates course outcomes.

**SECTION A**

(Answer **ANY THREE** questions from this section in Script A)

1. a) Suppose, there are 10,000 identical individuals in the market for the commodity  $x$  and the market demand equation is  $Q_{dx} = (120,000 - 20,000P_x)$  and 1000 identical seller with the market supply equation is  $Q_{sx} = 20,000P_x$ . (35) [CO3]
- i) Define law of demand.
  - ii) What is price ceiling and floor price?
  - iii) Obtain equilibrium price and quantity.
  - iv) Explain the factors that affect the supply curve to shift.
  - v) If the government imposes \$1 tax per unit sold from each of the seller, what effect does this have on the equilibrium price and quantity?
2. a) Define law of demand. Why the demand curve is downward slopping? (15) [CO2]
- b) "Karim Brothers" is a producer of cement. The corporation hired an economist to determine the demand for its cement. After months of hard work, the economist informed that the demand for the firm's cement is given by the following equation: (20) [CO4]
- $$Q_x = 20,000 - 5,000P_x + 5I + 500P_c$$
- where,
- $P_x$  = Price charged for Karim's cement.
  - $I$  = Income per capita.
  - $P_c$  = Price charged for competing producer's cement.
- Assume, the initial values of  $P_x$ ,  $I$  and  $P_c$  are \$5, \$10,000 and \$6 respectively. Using the above information, the MD wanted to determine:
- i) What effect a price increase would have on total revenue?
  - ii) Evaluate how sale of the cement would change during a period of rising incomes.
  - iii) Assess the probable impact if competing producer would raise their price?
3. a) Define unemployment. Explain various types of unemployment. (10) [CO3]
- b) Define national income and personal disposable income. Make a comparative analysis among different methods of national income. (15) [CO1]
- c) "Rising bank rate" – how does the central bank combat inflation? (10) [CO1]
4. a) Distinguish between monopolistic competition and monopoly. (05) [CO4]
- b) What do you understand by perfect competition market? Show with the aid of a graph the short-run equilibrium of a firm in perfect competition. (20) [CO1]
- c) What is the point do you think a firm should shut-down? (10) [CO1]

**SECTION B**

(Answer **ANY THREE** questions from this section in Script B)

5. a) What is accounting? Who are the users of accounting information? (10) [CO1]
- b) Identify and describe the steps in the accounting cycle. (10) [CO2]
- c) Write down the rules of "debit" and "credit" of account. (05) [CO1]
- d) How can you use your accounting knowledge as a computer science engineer? (10) [CO1]

6. a) On 1<sup>st</sup> January Mr. Aman started a business with cash Tk 300,000 and furniture worth Tk 80,000. Other transactions are as follows: (35) [CO2]

2022

- January 1 Office rent paid in cash Tk 15,000.  
 " 3 Cash deposited into bank 60,000.  
 " 4 An advertisement bill received but not yet paid Tk 6,000.  
 " 5 Office supplies purchase in cash Tk 4,000.  
 " 7 Advertisement bill paid by cheque (January 4).  
 " 8 Hired an office assistant for the month of salary Tk 14,000.  
 " 9 Utility bill received and paid in cash Tk 700.  
 " 10 Insurance premium paid in cash Tk 2,000.  
 " 12 Cash withdrawn from business for owner's personal use Tk 12,000.

Required:

- i) Prepare journal.  
 ii) Prepare a tabular summary and show the effects on accounting equation.

7. a) Define ledger. What purpose is served by ledger? (10) [CO2]  
 b) What are the limitations of trial balance? (05) [CO2]  
 c) From the following ledger balances of M/S Rahman & Sons, you are required to prepare a trial balance as on December 31, 2022. (20) [CO4]

Cash --- Tk 5000, Accounts receivable --- Tk 20,000, Supplies --- Tk 500, Equipment --- Tk 35,000, Accumulated depreciation - Equipment --- Tk 2,500, Building --- Tk 45,000, Accumulated depreciation - Building --- Tk 7,000, Accounts payable --- Tk 12,000, Salary payable --- Tk 4,000, Unearned service revenue --- Tk 2,500, Capital M/S Rahman --- Tk 85,000, Withdrawn Rahman --- Tk 8,000, Service revenue --- Tk 48,000, Salaries expense --- Tk 16000, Rent expense --- Tk 8,000, Supplies expense --- Tk 4,000, Advertisement expense --- Tk 5,000, Depreciation expense - Equipment --- Tk 5,000, Depreciation expense - Building -- Tk 6,000, Miscellaneous expense --- Tk 3,000.

8. a) Mr. Amin began operations as a private investigator on 1<sup>st</sup> January 2020. The trial balance for Amin at March 31 is as follows (for the quarter ending). (35) [CO4]

Account Titles	Debit (Tk)	Credit (Tk)
Cash	14,400	
Account receivable	7,620	
Supplies	1,250	
Prepaid insurance	4,400	
Equipment	38,000	
Notes payable		14,000
Accounts payable		14,350
Capital, Amin		28,000
Drawing, Amin	1,600	
Service revenue		17,620
Salaries expense	2,200	
Travel expense	2,000	
Rent expense	2,200	
Miscellaneous	300	
	73,970	73,970

Additional information:

- i) Supplies on hand at March 31, Tk 650.  
 ii) Depreciation on equipment is Tk 500 per quarter.  
 iii) Insurance expires at the rate of Tk 250 per month.  
 iv) Service provided but unbilled at March 31, Tk 950.

Required:

- i) Prepare a statement of comprehensive income for the quarter ended March 31, 2020.  
 ii) Prepare owner's equity statement.  
 iii) Prepare a statement of financial position as on March 2020.

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MATH 2207

Complex Variable, Vector Analysis and Statistics

TIME: 3 hours

FULL MARKS: 210

- N.B. i) Answer **ANY THREE** questions from each section in separate scripts.  
ii) Figures in the immediate right column of the questions indicate full marks.  
iii) The rightmost column indicates course outcomes.  
iv) Z-table,  $\chi^2$ -table, and graph paper will be supplied if required.

**SECTION A**

(Answer **ANY THREE** questions from this section in Script A)

1. a) The frequency distribution are given below: (25) [CO4]

No. of Students	5	8	11	18	7
Marks	40–60	60–80	80–100	100–120	120–140

- (i) Determine 1<sup>st</sup> four raw moments.  
(ii) Determine 1<sup>st</sup> four central moments.  
(iii) Determine the coefficient of Skewness and Kurtosis and comment on the nature of the distribution.

- b) A server has three data supply units – A, B, and C from which it receives 60%, 30% and 10% of the data, respectively. It has been obtained that 15% of the data from A, 90% from B, and 5% from C are defective. Given that data is received by the server. Calculate the probability that the data is defective and supplied form unit A. Also determine the overall probability of the data received by the server being defective. (10) [CO2]

2. a) Three emails, categorized as either spam or not spam, are randomly received. Define the random variable  $x$  as 2 times the number of spam emails minus 2. Develop the probability distribution for this random variable based on these emails. Calculate the mean, variance, and the coefficient of variation for the distribution. Additionally, determine the probability  $P(x < 3)$  and find the actual values of  $x < 3$ , respectively the number of spam emails, to further analyze the scenario. (10) [CO3]

- b) Given,  $F(x) = \begin{cases} \frac{Kx}{2} & \text{when } 6 \leq x \leq 10 \\ 0 & \text{otherwise} \end{cases}$  (15) [CO3]

Determine the value of 'K' that makes 'F(x)' a valid probability distribution function (PDF). After finding 'K', calculate the mean, standard deviation, and  $P(8 \leq x \leq 20)$ . Additionally, create graphical representations of both the probability density function (PDF) and PDF on a graph paper.

- c) Define Poisson Process. Given (10) [CO2]

The number of defective items	0	1	2	3
Observed in each 30-minute time span	2	5	4	2

- (i) Find the probability that one defective item observed within 2 hours.  
(ii) Find the probability that one defective item observed with both the time span 10:00 to 12:00 AM and 10:00 to 12:00 PM.

3. a) Write down the probability density function of standardized normal variate. Then prove that this forms a continuous probability distribution. Also write down five important properties of standard normal distribution. (12) [CO1]

- b) The mean weight of 2500 students is 55kg with SD 5kg. Assume that the weights are normally distributed. Find how many students weight (10) [CO3]  
(i) Between 50 to 60 kg;  
(ii) More than 160 kg (over weight);  
(iii) Less than 35kg (under weight).

- c) List the necessary properties of Bernoulli trials. In an automatic traffic control system, car speeds are monitored for over-speeding. Based on previous analysis, the probability of a car being over-speeded is 0.20. In a specific time frame, four cars are investigated. Calculate the probabilities for the following scenarios: (13) [CO4]  
(i) Green light (no over-speeded cars observed),  
(ii) Red light (all four cars over-speeded).  
(iii) Yellow light (otherwise i.e., mixed scenario of over-speeded and non over-speeded).

4. a) A moving particle is given by the parametric equation  $x = 2t, y = 2t$  and  $z = 2t^2k$ . (17) [CO4]  
Find unit tangent vector  $\hat{T}$ , normal vector  $\hat{N}$ , and radius of curvature at  $t = 0$ , then find the trihedral plane containing  $\hat{T}$  and  $\hat{N}$  at the point where  $t = 0$ .
- b) Write the relationship between two cartesian coordinate systems,  $(x, y, z)$  and  $(\acute{x}, \acute{y}, \acute{z})$  (18) [CO4]  
sharing the same origin but rotated by an angle  $\theta$ , expressed in matrix form. Given a triangle with vertices A(0, 0, 1), B(1, 0, 1), and C(0, 1, 1), first project it onto the  $xy$  plane. Apply a uniform shift of 3 units in the positive direction using matrix multiplication operator, followed by scaling along the axes with a scaling factor of 2 and  $-3$  along  $x$  and  $y$  axes respectively. Lastly, rotate the projected triangle  $90^\circ$  in anti-clockwise direction.

### SECTION B

(Answer ANY THREE questions from this section in Script B)

5. a) Express the following number in polar form (06) [CO1]  
(i)  $1 - i$ .  
(ii)  $-2i$ .
- b) Evaluate  $\oint_C \frac{\sin \pi z^2 + \cos \pi z^2}{(z-1)(z-2)} dz$  where  $C$  is the circle  $|z| = 3$ . (10) [CO1]
- c) Express  $|z + 3i| + |z - 3i| < 0$  in rectangular form and represent the region (07) [CO1]  
graphically in the  $z$  - plane.
- d) If  $w = 3iz - z^2$ , where  $z = x + iy$ , find  $|w|^2$  in terms of  $x$  and  $y$ . (06) [CO2]
- e) Find the location and nature of all singularities of  $Z = \frac{\cot \pi z}{(z^2 + 4z - 5)^2}$ . (06) [CO2]
6. a) if  $u - v = (x - y)(x^2 + 4xy + y^2)$  and  $f(z) = u + iv$  is an analytic function of (12) [CO3]  
 $z = x + iy$ , find  $f(z)$  in terms of  $z$ .
- b) Define harmonic function. Prove that  $u = 3x^2y + 2x^2 - y^3 - 2y^2$  is harmonic. Find (12) [CO2]  
the harmonic conjugate,  $v$ , such that  $f(z) = u + iv$ .
- c) A fluid motion is given by  $\vec{V} = (y \sin z - \sin x)\vec{i} + (x \sin z + 2yz)\vec{j} + (xy \cos z + (11) [CO2]$   
 $y^2)\vec{k}$ . Is the motion irrotational? Find the velocity potential.
7. a) Evaluate  $\nabla \left( \frac{1}{r} \right)$ ,  $\nabla \left( \frac{\vec{r}}{r} \right)$ , and  $\nabla^2 \left( \frac{1}{r^2} \right)$ , where  $\vec{r}$  is a position vector. (12) [CO2]
- b) Find the values of the constants  $a, b, c$  so that  $z = axy^3 + byz + cxz^2$  at  $(1, 2, -1)$  (11) [CO2]  
has a maximum of magnitude 64 in a direction parallel to the  $z$  axis.
- c) Find the equation for the tangent plane to the surface  $z = x^2 + y^2$  at the point (12) [CO2]  
 $(2, -1, 5)$ .
8. a) Evaluate  $\iint_S \underline{A} \cdot \underline{n} ds$ , where  $\underline{A} = 18z\vec{i} - 12z\vec{j} + 3y\vec{k}$  and  $S$  is that part of the plane (12) [CO2]  
 $3x + 2y + 6z = 12$  which is located in the first octant.
- b) Find the total work done in moving a particle in a force field given by (12) [CO3]  
 $\vec{F} = (3xy)\vec{i} - 5z\vec{j} + 10x\vec{k}$  along the curve  $x = t^2 + 1, y^2 = 2t^2, z = t^3$  from  $t = 1$   
to  $t = 2$ .
- c) Find the volume of the region common to the intersecting cylinders  $x^2 + y^2 = a^2$  and (11) [CO2]  
 $x^2 + z^2 = a^2$ .