

SECTION – A

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

1. (a) How can you organize the definitions of Artificial Intelligence (AI) along two dimensions and into four categories? What is a rational agent? (10)
- (b) Describe the role of Computer Engineering as one of the foundations of AI. (6)
- (c) Briefly describe the working principle of the subsumption robotic software architecture. What is an Augmented Finite State Machine (AFSM)? Draw an AFSM for the control of a single leg of a hexapod robot. (12)
- (d) What is the major difference between the AI robotics and the industrial robotics? Briefly describe the recent applications of any one of the following domains for robotic technology: (i) Robotic cars (ii) Health care (iii) Human augmentation. (7)

2. (a) What are the steps of the knowledge-engineering process? Explain the ontology of a domain by means of illustrative examples from the standard Wumpus world domain. (10)
- (b) What is a model of a logical language? Explain if the following two sentences are true or false: (i) $\exists x, y \ x = y$ valid? (ii) $\forall x, y \ x = y$ satisfiable? Justify your answer in terms of models for first-order logic. (9)
- (c) For the following description, construct a Datalog knowledge base and prove by forward-chaining that (i) Fred is Tom's grandfather (ii) Bill is Tom's uncle: "Fred is the father of Harry and Bill. On the other hand, Harry is the father of Tom and John." (11)
- (d) How can you distinguish between the propositional logic and the first-order logic in terms of the ontological commitment and the epistemological commitment? (5)

3. (a) What is the major difference between (i) special-purpose logics and higher-order logics (ii) the database semantics and the standard semantics of the first-order logic? (2+4=6)
- (b) State the Deduction theorem. Prove that the resolution inference algorithm is complete in the propositional logic. (12)
- (c) Why is the entailment for the first-order logic semi-decidable? Show that the forward chaining in the propositional logic is both sound and complete. (8+9=17)

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4. (a) What are major improvements of the DPLL model checking algorithm over the simple model checking algorithm? Also, explain how the DPLL algorithm achieves the required scale-up for solving large problems. (14)
- (b) How can you make plans by proportional inference? Why do we need the pre-condition axioms and the action-exclusion axioms? (12)
- (c) What is the frame problem in AI? Distinguish between the representational frame problem and the inferential frame problem. (9)

SECTION-B

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

5. (a) "Surely computers cannot be intelligent—they can do only what their programmers tell them." Is the latter statement true, and does it imply the former? (15)
- (b) What is the aim of Turing test towards understanding intelligence? Why is the concept of this test important in the field of Artificial Intelligence? (10)
- (c) Explain the advantages and pitfalls of greedy search. (10)
6. (a) Explain why problem formulation must follow goal formulation. Define the terms: agent, agent program, autonomy, and learning agent. (10)
- (b) Give a PEAS description for each of the following activities: (15)
- (i) Shopping for used AI books on the Internet
 - (ii) Bidding on an item at an auction
 - (iii) Playing soccer
- (c) Assume two heuristic functions h_1 and h_2 , both of which are admissible and applicable to your problem. It has been recommended that you should try to combine them to make a more general heuristic function h , which can be defined as (10)

$$h(s) = \alpha_1 h_1(s) + \alpha_2 h_2(s)$$

Here s denotes any state in the search problem, and the constants α_1 and α_2 are constrained such that they are non-negative and $\alpha_1 + \alpha_2 = 1$. Is the function h always admissible? Justify your answer with a specific example.

7. (a) Give a complete problem formulation for each of the following. Choose a formulation that is precise enough to be implemented. (10)
- (i) Using only four colors, you have to color a planar map in such a way that no two adjacent regions have the same color.

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Contd... Q. No. 7(a)

- (ii) A 3-foot-tall monkey is in a room where some bananas are suspended from the 8-foot ceiling. the monkey would like to get the bananas. the room contains two stackable, movable, and climbable 3-foot-high crates.
- (b) Describe Iterative Deepening A*(IDA*) search algorithm in detail. Your answer should include the algorithm's pseudo-code and a general description of how it works. (15)
- (c) Give two reasons why the IDA* algorithm might prove unsuitable as a solution to a search problem. In each case, give a brief explanation of why this is the case and suggest one potential solution for each of them. (10)
8. (a) Why chronological backtracking might be sub-optimal in solving Constraint Satisfaction Problems (CSPs). Discuss this fact with a specific example. (5)
- (b) Describe the necessity of alpha-beta pruning in the context of adversarial search. how genetic algorithm and simulated annealing are able to solve the local optima problem of greedy search algorithm. (15)
- (c) A binary CSP has a set $X = \{x_1, \dots, x_n\}$ of variables, each having a domain $D_i = \{v_{1i}, \dots, v_{ni}\}$ of values. In addition, a CSP has a set $C = \{C_1, \dots, C_m\}$ of constraints, each relating to a subset of X and specifying the allowable combinations of assignments to the variables in that subset. (15)
- (i) Given a binary CSP, define what it means for a directed arc $x_i \rightarrow x_j$ between variables x_i and x_j to be arc consistent. Discuss how $x_i \rightarrow x_j$ can fail to be arc consistent. Explain how this can be solved.
- (ii) Describe the AC-3 algorithm for enforcing arc consistency.
- (iii) Prove that the time complexity of the AC-3 algorithm is $O(n^2 d^3)$, where d is the size of the largest domain.
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SECTION – A

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

1. (a) Consider the following function table (Table 1 for Question no. 1 (a) for an Arithmetic Unit (AU). This AU has been implemented using n-bit Full Adder (FA) circuit, where X and Y represent two input variables of FA. Here, A and B are both n-bit binary numbers. The three bits function select for the AU is also shown in the table. Using the provided table data, calculate the effect of output carry (C_{out}) in this AU and also comment on the output of C_{out} . (15)

Function Select $S_1 S_0 C_{in}$	X	Y	Output F =
0 0 0	A	0	A
0 0 1	A	0	A+1
0 1 0	A	B	A+B
0 1 1	A	B	A+B+1
1 0 0	A	B'	A+ B'
1 0 1	A	B'	A+ B'+1
1 1 0	A	1	A-1
1 1 1	A	1	A

Table 1 for Question no.1 (a)

- (b) Using JK flip-flops design one typical stage of a register that performs the following logic micro-operations (draw necessary figures): (10)

P1: $A \leftarrow A + 1$ (Increment)

P2: $A \leftarrow (A \vee B)'$ (NOR)

Here, P1 and P2 are control variables.

- (c) Describe pros and cons of using *Booth's Algorithm* for multiplication. Briefly explain, what does *Modified Booth's Algorithm* do when it detects a sequence of 101 in the Multiplier? (10)

2. (a) Design a multiplier using *Booth's Algorithm* for two n-bit signed 2's complement numbers. Your design must contain followings: (25)

(i) Equipment Configuration

(ii) Derivation of the Algorithm with Flow-chart

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Contd ... Q. No. 2(a)

(iii) Control State Design

(iv) Data- Processor Specification

(b) Suppose, A and B using are both 2's complement numbers. How can you detect six relational logic between A and B using only subtraction operation? Show the effects of status bits (Zero Flag, Sign Flag, Overflow Flag, and Carry Flag) in terms of Boolean functions. (10)

3. (a) Suppose, in a 4-bit computer design you have found that it requires 35 control signals to control the computer. You have decided to design this controller using micro-programming. In your lab, you have found that only $2^{10} \times 8$ ROM is available. Is it possible to design the controller using only the stated ROM above? If your answer is yes then show the block diagram, otherwise explain why it is not possible. (10)

(b) Design the following combinational circuit using a ROM: the circuit accepts a 3-bit number and generates an output binary number equal to the square of the input number. (10)

(c) Multiply the following signed 2's complement 8-bit numbers using *Modified Booth's Algorithm*. Show all the steps. Verify your answer by converting A and B and your result ($A \times B$) to decimal.

Multiplicand, A = 1010 1011 Multiplier, B = 0101 1101 (15)

4. (a) Write machine cycle description for CALL, LDA, and PUSH instructions in SAP-2 architecture. (15)

(b) Differentiate between ADD and ADC operations with an example for SAP-3 architecture. (5)

(c) Differentiate between RAR and RAL operations with an example for SAP-3 architecture. (5)

(d) SAP-2 has a clock frequency of 1MHZ. This means that each T state has duration of 1 μ s. How long does it take to execute the following SAP-2 subroutine? (10)

```
MVI A, 0AH
LOOP1: MVI B, 64H
LOOP2: MVI C, 47H
LOOP3: DCR C
      JNZ LOOP3
      DCR B
      JNZ LOOP2
      DCR A
      JNZ LOOP1
      RET
```

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SECTION-B

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

5. (a) Assume in a project, Shahid has to design a system that displays a 7- digit BCD number. to accomplish the task, Shahid connects Intel 8086 with a seven 7- segment common-anode displays using seven 7447s (BCD-to-Seven-Segment Decoder.) He knows that each segment of a 7- segment LED requires a current between 5 and 60 mA to light. He designs the system such that each segment of a 7- segment LED will get a current of 40 mA. He knows that voltage drop across the LED when it is lit is 1.5V. He also knows that the output low voltage for the 7447 is 0.4V at 40 mA. (3+3+8+3=17)

Now answer the followings:

- (i) Find out the resistance of the current limiting resistors that Shahid should use in his design.
- (ii) How much current will be required in the worst case to drive the seven 7- segment LEDs and seven 7447s according to Shahid's design?
- (iii) Suggest Shahid any other power-efficient design to connect the seven 7- segment LEDs with the 8086. Describe your suggestion using the necessary connection diagram.
- (iv) How much current will be required to drive the LEDs and decoders according to your suggested design in the worst case?

(b) 8086 is a 16-bit microprocessor that uses port-mapped I/O technique. Suppose, an 8086 is currently connected to communicate with media card reader through port A of 8255. Port A of 8255 is currently configured in bidirectional handshake I/O mode. The timing diagram for one byte of data transfer from 8255 to the media card reader and vice-versa is given in the figure for Question 5 (b). An event in the transfer process is marked by an event ID surrounded by a circle on the timing diagram.

(2×9=18)

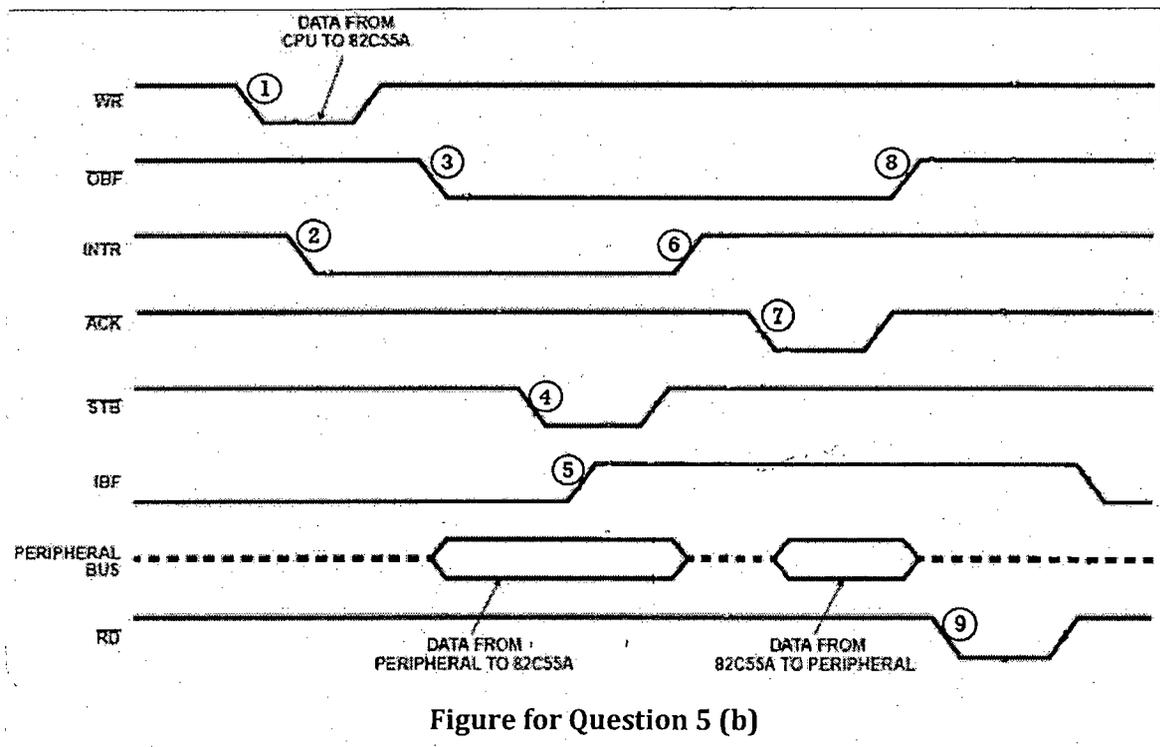


Figure for Question 5 (b)

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

Now describe each event as per the following table format.

Event ID	Description
1	
2	
3	
4	
5	
6	
7	
8	
9	

6. (a) Assume, two programmable interrupt controller 8259s are connected to an 8086 using a 3-to-8 line decoder 74LS138. The truth table of 74LS138 is given in the figure for Question 6 (a).

(17+12=29)

Inputs					Outputs							
Enable		Select										
G1	G2 (Note 1)	C	B	A	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
X	H	X	X	X	H	H	H	H	H	H	H	H
L	X	X	X	X	H	H	H	H	H	H	H	H
H	L	L	L	L	H	H	H	H	H	H	H	H
H	L	L	L	H	H	L	H	H	H	H	H	H
H	L	L	H	L	H	H	L	H	H	H	H	H
H	L	L	H	H	H	H	L	H	H	H	H	H
H	L	H	L	L	H	H	H	H	L	H	H	H
H	L	H	L	H	H	H	H	H	H	L	H	H
H	L	H	H	L	H	H	H	H	H	H	L	H
H	L	H	H	H	H	H	H	H	H	H	H	L

Figure for Question 6 (a)

One 8259 is working as a master and the other as a slave. System addresses for the two internal addresses of the master 8259 are 4F00_H and 4F02_H. System addresses for the two internal addresses of the slave 8259 are 4F01_H and 4F03_H. One 8254 is also connected to the microprocessor so that the counters of 8254 can be accessed from the microprocessor using the following addresses:

Counter	Address
0	09F3 ₁₆
1	09F2 ₁₆
2	09F1 ₁₆

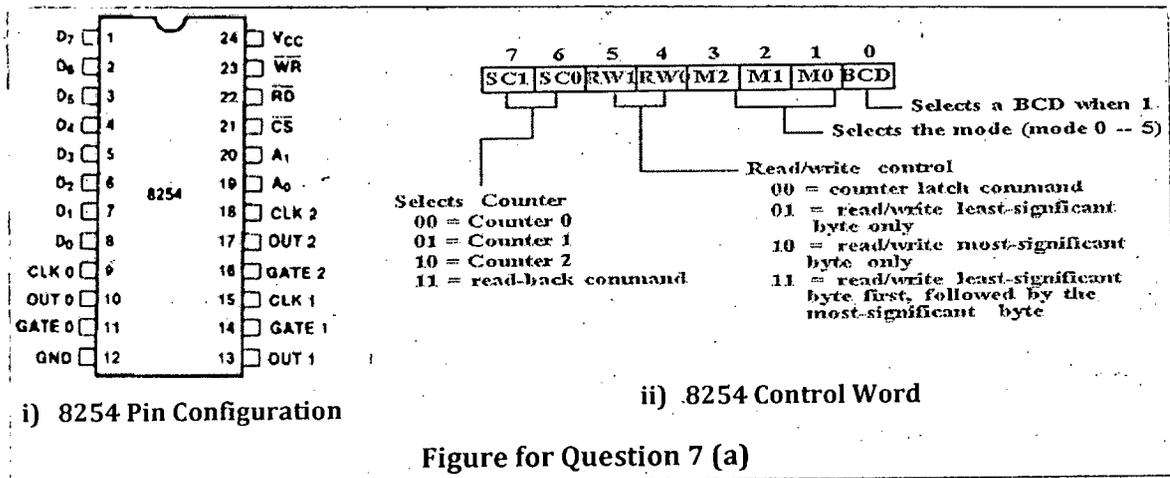
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Contd ... Q. No. 6(a)

Counter 0 of 8254 is configured to generate interrupt to the microprocessor through the slave 8259 on 1000th occurrence of a specific event. **Now answer the followings:**

- (i) Describe the above scenario using the necessary connection diagram.
 - (ii) How does the interrupt from counter 0 of 8254 get service from the 8086 in the above design? Describe using necessary timing diagrams.
- (b) Illustrate the difference between mode 1 (Hardware-retrigger able one-shot) and mode 5 (Hardware-triggered strobe) of programmable interval timer 8254 using suitable timing diagrams. (6)

7. (a) Intel 8254 is a programmable interval timer. Pin configuration and the control word format of 8254 are given in the figure for Question 7(a). (7+10+3=20)



8254 is connected with a microprocessor such that the timers of 8254 can be accessed from the microprocessor using the following addresses in memory-mapped I/O technique:

Counter	Address
0	04F1 ₁₆
1	04F0 ₁₆
2	04F3 ₁₆

Initially, the counter 0 of 8254 is configured to generate interrupt to the microprocessor on the 99th occurrence of a specific event. Four clock pulses after the initial configuration, the counter is reloaded with a value four. Two clock pulses later, Gate 0 is set to low for two clock pulses, (assume that a clock begins with a rising edge.)

Now describe the above scenario along with the output from the counters of 8254 with necessary connection and timing diagrams. Show the value of required control word in the timing diagram.

- (b) Give a brief comparison between an SRAM and a DRAM. (9)
- (c) Describe the idle and active cycle of programmable DMA controller 8237. (6)

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8. (a) Intel 2118 is a 16Kx 1-bit DRAM. Answer the following questions in respect to 2118. **(1+1+1+2+3+6=14)**
- (i) How many unique addresses are there in the DRAM?
 - (ii) How many address lines are required to address a unique location in the DRAM?
 - (iii) How many address lines are actually there in the DRAM?
 - (iv) Why the numbers of required and actual address lines are not equal in the DRAM?
 - (v) Briefly describe the steps to select a unique address in the DRAM.
 - (vi) Describe the write cycle of the DRAM using a timing diagram.
- (b) Why is it necessary to refresh memory cells of a DRAM? Describe the procedure that the Intel 2118 uses to refresh its memory cells. **(3+4=7)**
- (c) How manufacturers have made DRAM to function like SRAM? **(2)**
- (d) Give a brief comparison of block and demand transfer mode of programmable DMA controller, 8237? **(5)**
- (e) Write short notes on the followings. **(2×3.5=7)**
- (i) USB
 - (ii) PCI
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BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2015-2016

Sub : **HUM 411** (Business Law)

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**.

1. (a) What is contract? Give instances of technical contract. (7 ½)
- (b) Discuss in brief the basic elements of all types of contract. (8)
- (c) How long is an offer valid? Indicate the different ways of terminating the power of acceptance. (8)
2. (a) Define offer? Is language important to make an offer? (8)
- (b) When does an advertisement become an offer? Differentiate between offer and invitation. (8)
- (c) What is option? Explain the concept of counteroffers. (7 ½)
3. (a) Classify workers according to the existing law of our country. (8)
- (b) Differentiate between a temporary worker and a probationer. (7 ½)
- (c) What is mean by Retrenchment? What acts and omissions are treated as misconduct according to the labor act 2006? (8)
4. (a) According to the labor act 2006, what washing and canteen facilities should be present in a factory? Discuss elaborately. (8)
- (b) Discuss the provisions regarding rooms for children as per the labor act 2006. (8)
- (c) What precautions should be taken in an establishment in case of fire according to the law? (7 ½)

SECTION-BThere are **FOUR** questions in this section. Answer any **THREE**

5. (a) As a manager of a factory, what safety measures in case of fire and dangerous fumes will you need to take according to the labor act. (12 ½)
- (b) Discuss the rules regarding ventilation and temperature, overcrowding and lighting under the act of health and hygiene in the workplace. (11)
6. (a) Define company according to the companies act. (7 ½)

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Contd... Q. No. 6

- (b) Highlight the two immediate objectives for the enactment of the Companies Act. (8)
- (c) Classify company on the basis of control. Differentiate between private limited company and public limited company. (8)
7. (a) Discuss the rules relating to payment of maternity benefit in case of a women's death. (8)
- (b) Explain the procedure regarding payment of maternity benefit. (7 1/3)
- (c) Identify the characteristics of effective control. How can managers overcome the resistance to control? (8)
8. (a) Explain the aspects of a company. What is Memorandum of Association (MA)? (8)
- (b) Discuss the contents of Memorandum of Association. (7 1/3)
- (c) Who are promoters? Discuss the types and functions of promoters. (8)
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BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2015-2016

Sub : **HUM 211** (Sociology)

Full Marks: 140

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. Answer any **THREE**.

1. (a) Respond to those who assert that globalization is fueling nationalism, cultural reaction, and terrorist violence. (13 1/3)
(b) In particular, what combination of advantages allowed to experience industrialization first?(10)
2. (a) How did the technological innovations of the industrial revolution change the relationship between humans and their environment? (13 1/3)
(b) Critically discuss the population theory of Thomas Robert Malthus. (10)
3. (a) Compile the social problems and its impact on refugees and migrants arriving recently in European Countries. (13 1/3)
(b) Illustrate the social characteristics of a city. (10)
4. Write short notes on any THREE of the followings (23 1/3)
 - (i) Natural disaster
 - (ii) Religious bigotry and migration.
 - (iii) 'Love Canal' incident.
 - (iv) New Urban Sociology

SECTION-B

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

5. (a) Illustrate the factors contributed to the emergence of sociology as an independent discipline.(10)
(b) Discuss the properties of structural functionalism. (13 1/3)
6. (a) If you conduct a study on 'Facebook and social interactions' how will you design your research? Explain highlighting different steps of doing research in social sciences. (15)
(b) Explain the recent trends of nuclear family in Bangladesh. (8 1/3)

Contd P/2

HUM 211

7. (a) 'Technological involvement in our everyday life brings change in the roles of agents of socialization:- Give your critical opinion with suitable example. **(10)**
- (b) Briefly discuss G.H. Mead's model of socialization. **(13 1/3)**
8. Write short notes on any THREE of the followings: **(23 1/3)**
- (i) System of social stratification,
 - (ii) Types of socialization,
 - (iii) Classification of social mobility,
 - (iv) Marxist model of class differences.
-

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2015-2016

Sub : **HUM 213** (Government)

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**.

1. (a) Analyze the constituent elements of a modern state. (11 ⅓)
(b) What is nationalism? Discuss the merits of nationalism. (12)
2. (a) Discuss various types of sovereignty with examples. (11 ⅓)
(b) 'Rights simply duties' - explain the statement on the basis of citizen rights and duties. (12)
3. (a) Explain the functions of the Legislature in a state. (11 ⅓)
(b) Discuss the modern classification of government with relevant examples. (12)
4. Write short notes on any **THREE** of the followings: (23 ⅓)
 - (i) Rule of Law
 - (ii) Constraints of Good Governance
 - (iii) Theory of Surplus Value
 - (iv) Ideal Type of Bureaucracy

SECTION-BThere are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Distinguish between parliamentary and presidential forms of government. (11 ⅓)
(b) Discuss the role of opposition party in the parliamentary democracy. (12)
6. (a) Describe the causes and consequences of the language movement of 1952. (11 ⅓)
(b) Discuss the impact of the election of 1970 on the emergence of Bangladesh. (12)
7. (a) What is local government? Discuss the functions of urban local government in Bangladesh. (11 ⅓)
(b) Define constitution. Discuss the characteristics of Bangladesh constitution. (12)
8. (a) Discuss the external determinates of the foreign relations of Bangladesh. (11 ⅓)
(b) What is United Nations Organization? Discuss the functions of United Nations Organization in peace-keeping. (12)

SECTION – A

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

1. (a) What are maximum likelihood estimators? Write the desirable statistical properties of maximum likelihood estimators? (4+8=12)
 (b) For the **geometric (p)** distribution, derive the formula for MLE of the parameter p . Assume that we have IID data X_1, X_2, \dots, X_n from the mentioned distribution. (9)
 (c) Write a short note on P-P and Q-Q plots. Describe with appropriate figure when you will choose Q-Q plot over P-P plot. (7+7=14)

2. (a) Write the conditions for which a LCG should satisfy to have a full period. Without actually computing any Z_i 's determine which of the following mixed LCG's have full period. Give explanation behind your decision. (6+6=12)
 (i) $Z_i = (13 Z_{i-1} + 13) \pmod{16}$
 (ii) $Z_i = (Z_{i-1} + 12) \pmod{13}$
 (b) Why Multiplicative LCGs cannot have full period? Why m is chosen as a large prime instead of a power of 2? Here, 'm' carries its usual meaning. (6+5=11)
 (c) What is a **runs-up** test? What property is put under examination in **runs-up** test? For the following sequence of random numbers, find the **runs-down** of length from 1 to 6. Also give an expression of test statistic, **R** for the number of **runs-down** up to length 1, 2, 3, 4, 5 and ≥ 6 . For the expression you do not need to assume any values of a_{ij} , b_i and b_j . (12)

0.41	0.83	0.90	0.12	0.23
0.32	0.43	0.27	0.15	0.11
0.07	0.13	0.12	0.34	0.14
0.43	0.32	0.25	0.24	0.21
0.87	0.56	0.65	0.43	0.98

3. (a) The double exponential distribution has following density: (9)

$$f(x) = 0.5 e^{-|x|}; \text{ for all real } x.$$
 Give composition algorithm for generating random variables of density, f .
 (b) Plot the following density f

$$f(x) = \begin{cases} \frac{5x^2}{2} & \text{if } -1 \leq x \leq 1 \\ 0 & \text{otherwise} \end{cases} \quad (2+9=11)$$
 Give acceptance- rejection for generating random variate of density, f .
 (c) Derive a procedure of generating exponential random variates. (8)
 (d) Mathematically validate the random variate returned by Acceptance-Rejection method follows the desired distribution function. (7)

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4. (a) What is equiprobable approach for a chi-square test? What are the general guidelines in choosing intervals in a chi-square test? (12)
- (b) Suppose that $U_1, U_2, U_3, \dots, U_k$ are random variables. Show that the fractional part (i.e., ignoring anything to the left of the decimal point) of $U_1 + U_2 + U_3 + \dots + U_k$ is also uniformly distributed on the interval $[0,1]$. (10)
- (c) Distinguish between empirical and theoretical tests of random number generator. What is the common idea behind spectral test and lattice test? (7)
- (d) Describe the convolution method for generating random variates with an example. (6)

SECTION-B

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

5. (a) Briefly describe the steps in a simulation with an illustrative flow-chart. (15)
- (b) Differentiate between the next-event time advance and the fixed-increment time advance methods for the discrete-event simulation. What are the disadvantages of fixed-increment time advance method? (10)
- (c) Explain how to evaluate the integral $I = \int_a^b g(x) dx$ using Monte-Carlo simulation. (10)
6. (a) In a single server queuing system, arrivals of customers occur at times 0.4, 1.6, 2.1, 3.8, 4.0, 5.6, 5.8, and 7.2. Corresponding departures occur at times 2.4, 3.1, 3.3, 4.9, and 8.6, and the simulation ends at time 8.6. Compute (i) the average delay in queue, (ii) the average number of customer in queue, and (iii) server utilization. (12)
- (b) Suppose two stocks A and B have the following values in one week: (2, 5), (3, 8), (5, 10), (4, 11), (6, 14). If the stocks are affected by the same industry trends, will their prices rise or fall together? (10)
- (c) Consider a multiteller bank where the customers are allowed to jockey (move) from one queue to another if it seems to be to their advantage. (5+8)
- (i) Identify the events and draw the event graph.
- (ii) Show the Flowchart for function jockey of the bank model.
7. (a) X and Y are discrete random variables. Define the joint probability mass function of X and Y . (3)
- (b) State the conditions that a discrete time stochastic process need to satisfy to be covariance-stationary. (6)

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Contd... Q. No. 7

(c) Suppose that X and Y are jointly continuous random variables with

(10)

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

Find $\text{Cov}(X, Y)$.

(d) Define the probability density function and distribution function for an exponential variable with mean β .

(4)

(e) Describe two graphical techniques for informally assessing whether data X_1, X_2, \dots, X_n are independent.

(12)

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

(12)

(b) State the Strong law of large numbers.

(5)

(c) Define two types of errors that can be made while performing a hypothesis test.

(6)

(d) Discuss location, scale and shape parameters for continuous distribution with examples.

(12)

SECTION – A

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

1. (a) Given the following image in Figure 1(a), find its chain code representation using the primitives shown in Figure 1(b). (6)

Start from here

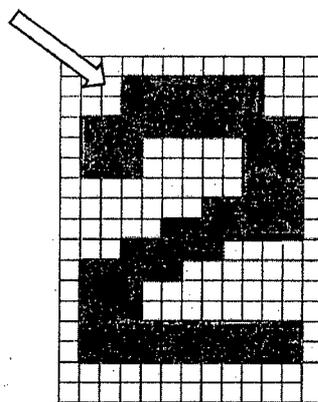


Figure 1(a)

Primitives

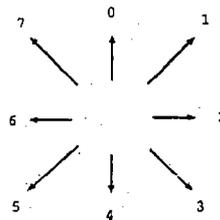


Figure 1(b)

- (b) Suppose, you want to create an image of size 1024×512 having 148 distinct intensity values. What will be the size of the image? (5)
- (c) What is D_m distance? Why is D_m distance necessary for calculating distance between two points in an image? Why isn't D_4 distance and D_8 distance enough? Explain with an example. (12)
- (d) Explain *unsharp* masking and high boost filtering in frequency domain. (12)
2. (a) Briefly describe ideal low pass filter (ILPF), Gaussian low pass filter (GLPF) and Buterworth low pass filter (BLPF). Define cutoff frequency D_0 for these filters. Show that ILPF and GLPF are special cases of BLPF. (17)
- (b) What is ringing effect? Why is ringing effect visible in ideal low pass filter (ILPF)? Explain in details. (10)
- (c) Find discrete Fourier transformation (DFT) for the following sampled function. (8)

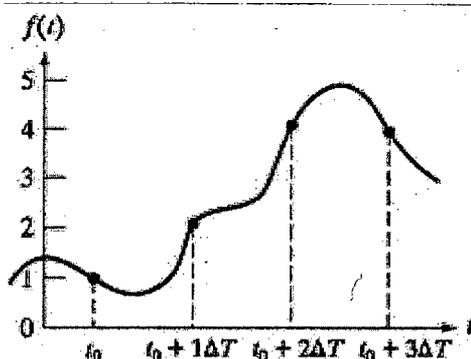


Figure for Question 2(c)

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3. (a) Consider the following table where the intensity probability of an image is given: (20)

r_k	$p(r_k)$
0	0.05
1	0.03
2	0.1
3	0.46
4	0.29
5	0.07

Apply Huffman coding and assign codes to each source symbols (r_k). Find the compression ratio compared to fixed length codeword size. Also apply arithmetic coding on the sequence "331402".

- (b) State the steps for frequency domain filtering briefly. (8)

(c) A sequence of 20 still images of a moving vehicle generates the spectrum for $G_y(u_2, a_2)$ with the first peak at $u_2 = 10$, $a_2 = 4$. The frame rate of the sequence is 35 frames/second and the distance between two pixels is equivalent to 0.5 meter. Find the speed of the vehicle in kilometers/hour. (7)

4. (a) What is Walsh-Hadamard Transform (WHT) and Discrete Cosine Transform (DCT)? Write down the equations of the kernel for these. Which one is the superior one and why? (10)

(b) Which one is the most optimal block transform coding and what is the problem of that coding? (5)

(c) Describe the delta modulation technique for lossy predictive coding. Given an input sequence {14, 15, 13, 16, 20, 33, 46, 70} with $\alpha = 1$ and $\zeta = 5.5$, show the steps of delta modulation process. From this example, explain slope overload and Granular noise. (20)

SECTION-B

There are **FOUR** questions in this section. Answer any **THREE**.
Any symbols have their usual meanings unless explicitly mentioned.

5. (a) Draw intensity transformation functions for the following three applications: (i) image negative, (ii) contrast stretching, (iii) thresholding. What is bit-plane representation of an image? What is the application of bit-plane decomposition of an image? (6+4+5)

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Contd... Q. No. 5

(b) Why histogram equalization of an image may be required? Consider a 3-bit image (number of intensity levels, $L = 8$) of size 64×64 pixels has the intensity distribution shown in the table below, where the intensity levels are in the range $[0,7]$. What will be the intensity distribution after applying histogram equalization to this image? You need to write the intensity levels and corresponding pixel frequencies in the histogram equalized image. Show detailed calculation steps. **(5+15)**

Intensity level, r_k	0	1	2	3	4	5	6	7
Pixel frequency, n_k	750	1000	860	700	340	250	120	76

6. (a) Why we may need to blur an image? Explain how the following two filtering methods work: (i) Order-Statistic filtering, (ii) Highboost filtering. **(5+5+5)**

(b) Consider the following horizontal intensity profile from an image. Calculate the first-order and second-order derivatives at each point and draw the corresponding intensity profiles. From the diagrams drawn, identify ramp, line and isolated noise with proper explanation. **(4+4+4+8)**

Image strip	6	6	5	4	3	2	1	0	0	0	8	0	0	0	1	3	1	0	0	0
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7. (a) Draw the intensity profiles of the following three edge models: (i) step, (ii) ramp, (iii) roof edge. **(6)**

(b) Explain how gradient based edge detection works. Your explanation must include the following: (i) all the required equations, (ii) description of the process, (iii) filter mask to be used. What are the limitations of gradient based edge detector? How Marr-Hildreth edge detector attempts to solve those problems? Explain. **(15+6+8)**

8. (a) Write down the algorithm for basic global thresholding. How is the initial threshold value required for the algorithm estimated? In which cases, this algorithm performs well? **(8+4+3)**

(b) Why Otsu's method for global threshold is called optimum? In which cases, variable thresholding is preferable over global thresholding? **(6+3)**

(c) Write down the steps of 'local processing' for edge linking. What are limitations of local processing for edge linking? **(8+3)**

SECTION – A

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

1. (a) Define the dual and the weak dual of a plane graph with illustrative examples. Prove that the weak dual of a biconnected outerplane graph is a tree. (4+6)
 (b) State and prove Euler’s formula for a connected plane graph. (8)
 (c) Draw a self-dual plane graph of seven vertices. (4)
 (d) What is a separating triangle in a triangulated plane graph? Prove that the number of separating triangles in a triangulated plane graph is at most $n-4$. (2+11)

2. (a) Construct a digraph G with five vertices such that the converse of G and the complement \bar{G} are isomorphic. (4)
 (b) Prove that, every tournament T contains a Hamiltonian path. (10)
 (c) Define the radius and the center of a graph with illustrative examples. Write an efficient algorithm for finding the center of a tree. (4+8)
 (d) Find canonical ordering for the triangulated plane graph in Figure.1. (9)

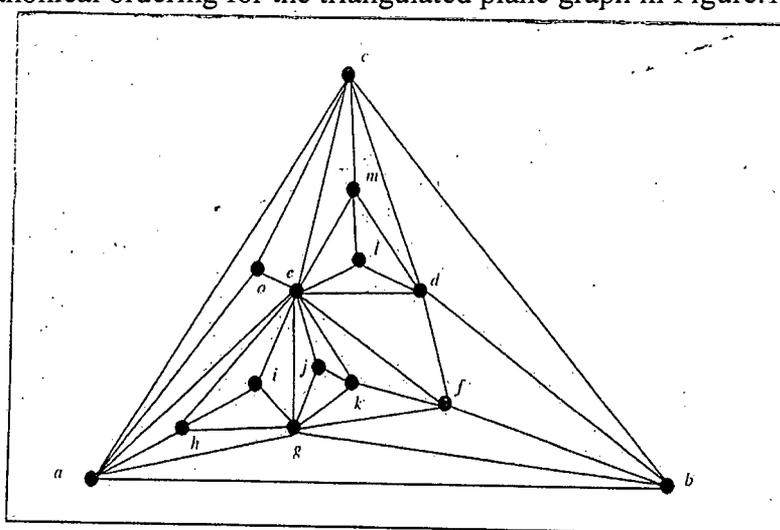


Figure 1: Figure for Question No 2(d)

3. (a) When do we call a matching a perfect matching? Find the number of perfect matching’s in K_n and $k_{n,n}$. (2+5)
 (b) A dominating set D of a graph G is an independent dominating set if D is an independent set of G . Show that D is an independent dominating set if and only if D is a maximal independent set. (8)
 (c) For the graph in Figure 2, find the following:
 (i) a maximal matching which is not maximum,

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Contd... Q. No. 3(c)

- (ii) a minimum vertex cover, and
- (iii) a maximum independent set.

(2+2+2)

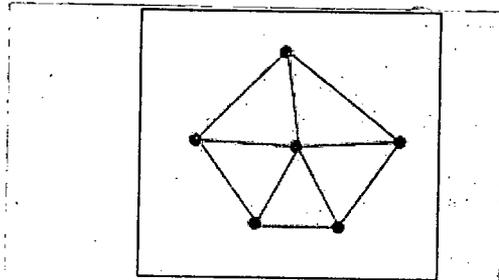


Figure 2: Figure for question number 3 (c)

- (d) Prove that every maximal planar graph of four or more vertices has at least four vertices of degree five or less. (5)
 - (e) Define (i) chordal graphs, (ii) interval graphs and (iii) series-parallel graphs with illustrative examples. (3+3+3)
4. (a) Let G be a bipartite graph with the maximum degree Δ . Then prove that, $\chi(G) = \Delta$. (12)
- (b) What is a k -critical graph? Construct a 4-critical graph. (3+3)
- (c) What does a chromatic polynomial $P_G(k)$ of a graph indicate? Prove that for a tree of n vertices $P_G(k) = k(k-1)^{n-1}$. (4+6)
- (d) Construct the tree corresponding to the pruffer's code 1, 3, 3, 7, 9, 9, 7 showing every step. (7)

SECTION-B

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

5. (a) There are five jobs $\{ J_1, J_2, J_3, J_4, J_5 \}$ in a company for which there are five workers A, B, C, D, E to do those jobs. However, everybody does not have expertise to do every job. The expertise is as follows: (15)
- $A = \{ J_1, J_2, J_3 \}$, $B = \{ J_2, J_4 \}$, $C = \{ J_1, J_3, J_5 \}$, $D = \{ J_3, J_5 \}$, $E = \{ J_1, J_5 \}$. Develop a graph model to represent the job expertise of the persons and find the assignment of jobs to the following workers, such that every worker can do a job. Draw the graph.
- (b) Write short notes on multigraph, maximum degree, k -regular graph, independent set. Give example for each. (4×3=12)
- (c) What is "complement" of a graph? Show that for any graph of six vertices, either the graph or its complement contains a triangle. (2+6=8)

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6. (a) What is a degree equivalent graph? What is a self-complementary graph? Give example for each. (3×2=6)
- (b) Show that the isomorphism relation is an equivalence relation on the set of graphs. (12)
- (c) Let G be a connected simple graph. Then $k(G) \leq k'(G) \leq \delta(G)$, where $k(G)$, $k'(G)$, $\delta(G)$ mean connectivity, edge connectivity and minimum degree of the graph G , respectively. (10)
- (d) Explain “ear decomposition” with an example. (7)
7. (a) Show that every u, v walk of a graph G contains a u, v path. [u, v are the vertices of G .] (6)
- (b) Let G be a simple graph of n vertices and m edges. If G has exactly K components, then prove that (15)
- $$n-k \leq m \leq (n-k)(n-k+1)/2$$
- (c) What is the cut-edge? “A connected graph G is Eulerian if and only if every vertex of G has even degree.” Prove the statement above. (4+10=14)
8. (a) What is a Hamiltonian graph? Give an example which is not Hamiltonian. (5)
- (b) Let G be a model simple graph of n vertices. Let u and v be two vertices in G such that $(u, v) \notin E(G)$ and $d_G(u) + d_G(v) \geq n$. Then G is Hamiltonian if and only if $G + (u, v)$ is Hamiltonian. (15)
- (c) Let g be a graph with n vertices. Then, any two of the following three statements imply the third (and characterize a tree of n vertices): (15)
- (i) G is connected.
 - (ii) G contains no cycle.
 - (iii) G has $n-1$ edge.
-

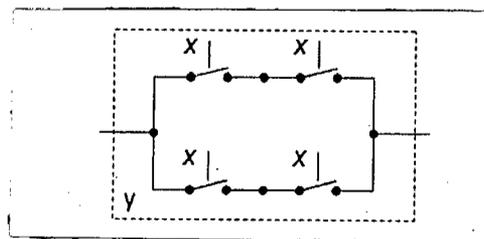
SECTION – A

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

1. (a) A computer application performs a certain type of critical computation. Arrival rate of requests of the critical computation to the application is λ , and rate of completing the computation by the application is μ . Here, no request of the critical computation arrives when the application is performing an ongoing computation. (25)
 Now, you need to determine the time variant probability (probability as a function of time) of the application to be in the idle state, where no request of the critical computation is taken care of. Also, you need to determine the steady-state probability of the application to be in the idle state.
 Show all figures and derivations needed to determine the two probabilities.
 (b) What are the steady-state probabilities of being in different states pertinent to a TMR system? Consider that the TMR system under consideration has a provision of repair for failure of only up to one available unit. Show necessary figures(s) and derivation assuming that failure rates of all the available units to be λ . (10)

2. (a) What is Burn-in and stress testing? How can it help in improving reliability? Explain with an example. (15)
 (b) Is there any difference between removal and masking approaches of defect circumvention? If yes, then elaborate the difference using an example. If not, then elaborate its underlying reason. (10)
 (c) Distinguish between interference and crosstalk. (10)

3. (a) A switch of a Heating, ventilation and air conditioning (HVAC) system is made in such a way that it remains closed during normal operation and gets open while crossing the expected level of operation. A relay device is used to operate as the switch. Accordingly, the relay device normally remains closed and gets open when it is energized during the crossing of expected level of operation. (25)
 Now, an engineer wants to make an arbitrarily reliable relay circuit out of available relay devices having the property as mentioned above. To do so, he adopts the following relay circuit, where x implies a relay device and y implies a relay circuit.



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Contd... Q. No. 3(a)

Your job is to find out whether the adopted relay circuit will meet the goal of making an arbitrarily reliable relay circuit. If so, explain why and how. If not, explain why not.

(b) Distinguish among electromagnetic, particle, and secondary radiations. (10)

4. (a) You are giving a memory module having 6×6 memory cells with one additional spare row and two additional spare columns. The spare ones are intended to circumvent defective memory cells. (25)

Design a mechanism of circumventing defective cells using the spare ones. Using your designed mechanism, show whether six defective cells can be circumvented with the available one spare row and two spare columns. Here, the defective cells are (R_0, C_2) , (R_0, C_4) , (R_1, C_2) , (R_2, C_2) , (R_5, C_1) , and (R_5, C_5) , where R refers to Row, C refers to column, and the subscript refers to index of position that starts from the index 0.

(b) How can we determine the optimal number of checkpointing to enable degradation allowance? (10)

SECTION-B

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

5. (a) A supercomputer needs its cooling system operational to make its computation. To enhance availability of the cooling system, a backup one remain in standby mode in addition to the primary cooling system. The backup one starts operational as soon as the primary one gets down.

Failure rates of both the primary and backup cooling systems exhibit the same value, which is 10^{-5} /Hour. Now, the supercomputer has assigned a task that needs to make computation over a period of 10 hours. Two engineers separately analyze fatality probability of the computation. (10)

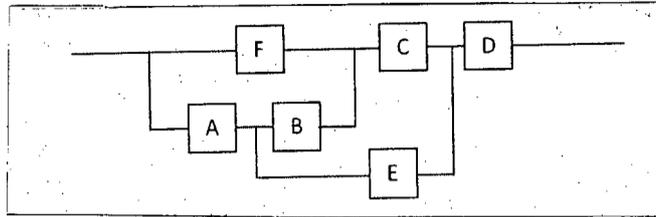
The first engineer adopts an optimistic approach assuming that only failures of the two cooling systems within the same hour are catastrophic. On the other hand, the second engineer adopts a pessimistic approach assuming that failures of the two cooling systems at any time are catastrophic.

Your job is to perform analyses from the perspective of both the engineers and calculate the fatality probabilities in both the cases.

(b) A system comprises six units, which are named as Unit A, Unit B, ..., and Unit F. Reliability of the units are R_A, R_B, \dots and R_F . Reliability block diagram of the whole system is shown as follows: (20)

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



You need to derive reliability of the whole system (R_{sys}) in terms of reliabilities of the units. Show all the steps that are needed to derive R_{sys} .

(c) What are the differences between Cut Set and Path Set? (5)

6. (a) In case of data transmission through a networking relay device, a certain extent of error may occur. Probabilities of the error are as follows: Probability of error while transmitting 1 through the devices is 10^{-1} and probability of error while transmitting 0 through the device is 5×10^{-2} . Besides, 40% of the digits transmitted through the device are 0 and the rest are 1. Now, a digit 1 comes out of the device. What is the probability that the actual bit under transmission through the device was 0? (10)

(b) What is instantaneous failure rate? Derive reliability in terms of instantaneous failure rate. Is instantaneous failure rate smaller than the probability distribution function? Justify your answer. (8+12+2+3)

7. (a) Should we always choose a system based on its MTTF, i.e., always choose a system having the highest MTTF? If so, elaborate why we should do so? If not, then what additional aspect(s) should be in consideration and why? (10)

(b) A system is composed of two repairable units. The system fails if both the components fail. In such a case, an immediate repair takes place. (25)

Failure rates of the two units (Unit 1 and Unit 2) are 0.0005 and 0.0002 respectively. Besides, repair time of Unit 1 is 100 hours. For Unit 2, a periodic check occurs in each 1000 hours. Here, Unit 2 becomes operational (repaired, if required) at the end of the checking period.

You need to find out average overall system failure rate. Show all the figures, steps, and calculations you need to do to derive the average overall system failure rate.

8. (a) Distinguish between the following terms: (5+5+5)

- (i) Reliability and availability
- (ii) Transient and intermittent faults
- (iii) Fault and failure

(b) What is N-Modular redundancy? How does the value of N exhibit an influence on overall design here? What would be the design in case of having $N = 3$? Point out advantages and disadvantages of having such a system with $N = 3$. (20)

SECTION – A

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

1. (a) Describe the contributions of Henri Fayol in classical organization theory school. (10)
 (b) According to the Henry Mintzberg, what roles do managers play in an organization? Discuss with suitable example. (9)
 (c) The following table shows the number of accidents that occurred on a highway during the last seven months: (16)

Month	No. of accidents
January	30
February	40
March	60
April	90
May	105
June	140
July	160

Forecast the number of accidents that will occur in August and October using least square regression to derive a trend equation.

2. (a) Briefly describe qualitative forecasting methods. (15)
 (b) Write short note on “Boundary less Organization.” (10)
 (c) Determine optimal number of products to order from the following information: (10)
 Annual demand is 14,000 units, ordering cost is Tk. 65 per order and holding cost per unit per year is 20% of product price.

Category	Discount Quantity	Product Price
1	0 to 500	Tk. 40.00
2	501 to 700	Tk. 35.00
3	701 and over	Tk. 30.00

Calculate the order quantity and total cost.

3. (a) Explain the term ‘Holding Cost’. Which cost items can be considered as Holding Cost? (7)
 (b) Explain Equity Theory in detail. (10)
 (c) Suppose that 5 jobs will be processed on a single machine. Processing time and due dates are given in the following table. Choose the best sequence using FCFS, SPT and EDD rules: (18)

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Contd... Q. No. 3 (c)

Job	Processing Time (day)	Due Date (day)
A	4	3
B	8	7
C	6	5
D	9	8
E	5	6

Also explain the logic behind your decision.

4. (a) What do you mean by authority delegation? Discuss the advantage and prerequisites of authority delegation. (15)
- (b) Assume that product Z is made of two units of A and four units of B. A is made of three units of C and four units of D. D is made of two units of B. Lead times for purchasing or manufacturing each unit to final assembly are: Z takes two weeks; A, C and D take one week each; and B takes three weeks. 185 units are required in period 10. (20)
- (i) Show the bill of materials.
- (ii) Develop a Materials Requirement Plan showing gross and net requirements, order release and order receipt dates.

SECTION-B

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

5. (a) What are the stages of group development? Explain briefly. (11)
- (b) What is meant by cost of quality? How this cost of quality may incur in a microchips manufacturing company? (12)
- (c) Royal Electronics Co. Ltd. manufactures digital camera, projector and scanner. The yearly sales and expenses in 2016 are shown in the following table: (12)

	Camera	Projector	Scanner
Sales volume (units)	10,000	7,500	8,500
Selling price (\$/unit)	100	600	80
Variable expense(\$/unit)	75	530	58
Fixed expense (\$)	850,000		

Find-

- (i) Break-even quantities of the product mix
- (ii) CM ratio and margin of safety of each product
- (iii) If the company wants to earn a profit of \$250,000 in 2017 what should be the sales volume of the product mix?
6. (a) Suppose, you have opened a deposit skim and have planned for the following amounts of deposits at the nominal interest rate of 13.5%. (15)

Year	Cash Flows (\$)
0	-1,000
1	-2,000
2	-3,500
3	-2,500
4	-3,000

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Contd... Q. No. 6 (a)

Find the Future worth–

- (i) if the interest is compounded annually
 - (ii) if the interest is compounded quarterly
 - (iii) if the interest is compounded continuously
- (b) What is MARR? What factors do contribute in determining MARR? (5)
- (c) Select one of the following alternative projects according to–
- (i) NPV
 - (ii) Discounted payback period (15)
- use interest rate 15%.

Year	Cash Flows (\$)	
	Project 1	Project 2
0	-100,000	-150,000
1	10,000	20,000
2	40,000	80,000
3	80,000	120,000
4	70,000	70,000
5	60,000	20,000

7. (a) In a factory, a worker is given to produce 85 pieces of handmade bags. The standard task for manufacturing bags is 10 pcs/hr and Guaranteed base rate is 62tk/hr. Low task would be 75% of the standard task. If the worker take 7hrs to complete the given task, find the wage for the job and the rate of incentive per hour for the worker according to– (15)
- (i) Rowan Plan
 - (ii) Bedeaux Plan
 - (iii) Halsey Plan (Percentage of the workers' share in gain above the task is 30%).
- (b) According to Blake Mouton Managerial Grid discuss the current leadership style in an apparel manufacturing company. (15)
- (c) What is group cohesiveness? How does it affect the productivity of the group? (5)
8. (a) What do you understand by TQM? Discuss the characteristics of TQM. (15)
- (b) What are the factors that may influence behavior of a married women in Bangladesh in case of buying a dress for herself? (8)
- (c) Briefly describe S-curve and Technology life cycle curve for digital camera. (12)
-