SECTION – A

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

1. (a) Discuss the different ways of transferring data between a digital system and a physical I/O device.  
(b) Discuss the various modes of operation of 8237 in active cycle.  
(c) The command register of an 8237A contains AAI6. Explain the operation of this 8237A.  

2. (a) Explain why key-switches of a keyboard are arranged in a matrix and how a key press is identified.  
(b) Explain (i) 2-key lockout, (ii) N-key rollover, (iii) encoded and (iv) decoded scan operation of 8279.  
(c) The status register of an 8279 contains O016. Explain the current status of this 8279.  

3. (a) Draw a general block diagram of a up-based system.  
(b) A up-based voltmeter is to be designed. Input to the voltmeter will be an analog voltage of maximum 9.9 V. Output should be displayed in two 7-segment displays – left display shows the integer value and right display shows the fractional part. \(9+10+9 = 28\)  
   (i) Draw a block diagram showing inter-connections of all the hardware components.  
   (ii) Discuss the different components you will use.  
   (iii) Discuss the addressing scheme you will use showing how the chip select signals will be generated for different chips.  

4. (a) Implement the logic function \(F = \sum(1,3,5,7,11,13)\) using one 4-to-1 MUX. Extra basic logic gates, if necessary, can also be used.  
(b) Design an excess-4 to binary converter using a 4-bit adder chip only.  
(c) Explain the initialization process of 8259.  
(d) The OCW1 of an 8259 is AA16. Explain its meaning.
5. (a) Assume that you have to design a 4 bit ALU using full adders that has two selection variables $S_1$ and $S_2$ and generates the following arithmetic and logical operations. (15+10=25)

<table>
<thead>
<tr>
<th>$S_1$</th>
<th>$S_2$</th>
<th>$C_{in} = 0$</th>
<th>$C_{in} = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>$F = A - 1$</td>
<td>$F = A$</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>$F = A + B$</td>
<td>$F = A + B + 1$</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>NOR</td>
<td>NOR</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>XOR</td>
<td>XOR</td>
</tr>
</tbody>
</table>

(i) Design the arithmetic unit and write down the general equation of $X$, $Y$ and $Z$ for each full adder where the symbols have their usual meaning.

(ii) Modify the general equations of the arithmetic unit design to incorporate the logical operations.

(b) For each arithmetic operation designed in 5(a), write down the condition for which output carry is 1 i.e. $C_{out} = 1$. Convert the functions in a form that can support your answer. (5)

(c) What is overflow? Mention the conditions where overflow can occur. (5)

6. (a) Draw a flowchart and a state diagram of a system that performs multiplication of two binary numbers in signed-magnitude representation. Design the control unit following PLA control method. [You must show the PLA program table and the block diagram of the unit.] (5+5+10=20)

(b) A control unit has two inputs $x$ and $y$ and 8 states. The state diagram is shown in Figure 6(b). Design the control unit using sequence register and decoder method. (Control signals have been omitted for the sake of simplicity assuming that they can be derived from the state signals trivially.) (15)
7. (a) Answer the following questions regarding SAP-1 architecture. The block diagram has been provided in Figure 7(a).

(i) The positive clock edge occurs halfway through each state. Why is this important?

(ii) During the final T-state of ADD or SUB instruction, the accumulator sets up the adder-subtractor and halfway through this state the positive clock edge loads the accumulator. Does this design introduce racing? Briefly explain your answer.

(iii) Describe what is performed during each T-state of an LDA instruction.

(iv) Draw the timing diagram of ADD instruction.

(b) Draw the circuit diagram to implement a 4 bit Accumulator, which computes the 2's complement of the current value of the accumulator and stores the result back into the accumulator, when control variable \( p_n \) is enabled. Use J-K flop-flops in your design.

8. (a) "SAP-2 architecture supports nested function call" – is this statement correct? Explain why?

(b) Assume that SAP-2 has a clock frequency of 1 MHz. How much delay does the following SAP-2 subroutine produce? The required number of T-states for each instruction is given in Table 8(b).

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Required T-states</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVI B,0AH</td>
<td></td>
</tr>
<tr>
<td>LOOP1:</td>
<td>MVI C,47H</td>
</tr>
<tr>
<td>LOOP2:</td>
<td>DCR C</td>
</tr>
<tr>
<td></td>
<td>JNZ LOOP2</td>
</tr>
<tr>
<td></td>
<td>DCR B</td>
</tr>
<tr>
<td></td>
<td>JNZ LOOP1</td>
</tr>
<tr>
<td></td>
<td>RET</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Required T-states</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVI</td>
<td>7</td>
</tr>
<tr>
<td>DCR</td>
<td>4</td>
</tr>
<tr>
<td>JNZ</td>
<td>10/7</td>
</tr>
<tr>
<td>RET</td>
<td>10</td>
</tr>
</tbody>
</table>

(c) Write down the steps of PUSH operation in SAP-3.

(d) Draw two diagrams to show the difference between RCR and RAR operations?

(e) Draw a block diagram of the internal organization of a D-RAM chip. What is refreshing? Why it is required? How it is done?
Figure 6(b)

Program counter

Input and MAR

16 x 8 RAM

Instruction register

Controller/sequencer

Accumulator A

Adder/subtractor

B register

Output register

Binary display

CSE 403

Figure 7(a)
SECTION – A

There are FOUR questions in this Section. Answer any THREE.

1. (a) "All agreements are contract but all contracts are not agreement". Do you agree with this statement? Explain with example. (3½)

(b) Does marriage make a contract? Explain by stating all the components of contracts. (10)

(c) You have received an appointment letter that requires you to acknowledge and confirm the joining within 7 days. You have posted a letter but the letter was not reached within 7 days. Is there any contract between you and your employer? (5)

(d) You have offered to sell a flat in Dhaka to Mr. X for Tk. 5,000,000. The offer is communicated through express letter. The letter was delayed in censor’s office. Before your letter reaches to Mr. X, X has received a mail revoking the offer. Advise Mr. X. (5)

2. (a) Differentiate among void, voidable, unenforceable, illegal and valid contract. (8½)

(b) Mr. X is an unsound person. He normally remains unsound for 20 hours a day. You have purchased a land from Mr. X and at the time of preparing and signing the deed of the land he was of sound mind. Explain whether the contact is valid or not. (5)

(c) A shopkeeper supplied a toy having price Tk. 5000 to a minor on credit. The guardian of the minor refused to pay for the toy. Can the shopkeeper recover the price? Explain. (5)

(d) Mr. A sold a cow to Mr. B by stating that the cow gives milk of 4 liter per day. B found that the cow gives 3.5 liter milk per day. Was the contract valid? Explain. (5)

3. (a) Differentiate between wagering agreement and contingent contract with example. (8½)

(b) Akash agrees with Asheek that if there is no rain on Monday, Akash will pay Tk. 1000 to Asheek and if there is no rain on that day, Asheek will pay Tk. 1000 to Akash. Is it a contract? Explain. (5)
HUM 411
Contd ... Q. No 3

(c) Mr. A has lost his mobile phone and announced to reward Tk. 1000 who will make him find it. Is it a contract? Explain. (5)

(d) ABC Ltd. has given assurance to Mr. Y that it will compensate the loss of goods in the factory if the goods are destroyed by fire. The goods were destroyed deliberate fire of Mr. A as the price of the goods was lower than the cost. Can Mr. Y claim his loss? (5)

4. (a) State the provisions regarding working hour for employees as per labor law, 2006. (6)

(b) What are the types of employee leave? Explain the provision for each type of leave. (6)

(c) Differentiate among retrenchment, discharge and dismissal. Explain different types of worker. (6)

(d) State the provisions regarding the termination of employment of a worker. (5 1/2)

SECTION - B

There are FOUR questions in this Section. Answer any THREE.

5. (a) “Although a company is a separate entity, sometimes it is needed to lift the corporate veil” explain the statement by focusing on the case of Jones VS Limpan. (8)

(b) You are going to form a public limited company. What are the steps you need to follow to start the company? (8)

(c) Differentiate between private limited company and public limited company. (7 1/2)

6. (a) Differentiate between share and debenture. (8)

(b) Differentiate between ordinary share and preference share. (8)

(c) What are the different types of share capital? Discuss issuing share at premium and discount. (7 1/2)

Contd ........... P/3
7. (a) Who are the members of Board of Directors? State the rules regarding appointment and removal of directors. (8)

(b) What are the five components of financial statements? Explain. (7½)

(c) Who can be the auditor for a company? State the provisions regarding the appointment and removal of auditor. (8)

8. (a) What are the considering factors while conducting a meeting? (8)

(b) ABC Ltd. has commenced its business in January 1, 2014. It holds its statutory meeting at January 25, 2014. The statutory report was issued 14 days before the meeting. The company holds its first AGM on August 1, 2015. The next AGM was declared on August 1, 2016 but the meeting was adjourned and was held in January 1, 2017. The next meeting will be held on March, 2018. Requirement: find out the irregularities regarding the meeting of the company. (7½)

(c) “Liquidation and dissolution have same meaning” do you agree? When a company will be liquidated the order of the court? (8)
L-4/T-1/CSE Date: 22/02/2018

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2016-2017

Sub: HUM 211 (Sociology)

Full Marks: 140 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are FOUR questions in this Section. Answer any THREE.

1. (a) 'Sociology is a categorical discipline not a normative discipline' – Explain this statement highlighting the nature of sociology. (10)

   (b) Make a comparison between functionalist perspective and conflict perspective. (13 ½)

2. (a) What is patriarchal family? Write the main features of a patriarchal family. (10)

   (b) 'Traditional functions of family have been more modified than lost' – discuss this by analyzing the changing structure and functions of a family. (13 ½)

3. (a) What do you understand by social stratification? How do diverse systems of social stratification facilitate social inequality in a society? (10)

   (b) Discuss different types of social mobility with examples. (13 ½)

4. (a) What is socialization? Explain primary socialization and anticipatory socialization with examples. (10)

   (b) Evaluate the various roles of different agents of socialization. (13 ½)

SECTION – B

There are FOUR questions in this Section. Answer any THREE.

5. (a) What were the social, economic and political impacts of industrial revolution in Europe? (13 ½)

   (b) Elaborate the factors contributing to globalization. (10)

6. (a) Compile the crucial elements of demography. How do these elements help to understand population dynamics? (13 ½)

   (b) Explain how the internet promotes global culture. (10)
HUM 211 (CSE)

7. (a) Explain the socio-economic features of pre-industrial, industrial and Post-industrial cities.

(b) What is urban community? Describe the salient features of urban community.

8. Write short notes on any THREE of the following:

(a) Internal migration

(b) Feudalism

(c) Noise pollution

(d) The Chernobyl disaster.

================================================================================================
SECTION - A

1. (a) Discuss the constituent elements of a state. (11½)
   (b) What is nationalism? Describe the merits of nationalism. (12)

2. (a) What is constitution? Describe the qualities of a good constitution. (11½)
   (b) Make a comparative discussion between democracy and dictatorship. (12)

3. (a) Describe the impact of 1970 election on the emergence of Bangladesh. (11½)
   (b) Make a comparison between the political systems of UK and USA. (12)

4. Write short notes on any three (3) of the following: (23½)
   (a) Language movement
   (b) Despotic type of government
   (c) Internationalism
   (d) United Nations Organization (UNO)

SECTION - B

5. (a) Who is a citizen? Analyze the methods of acquiring citizenship. (11½)
   (b) Explain the political rights and duties of a citizen in a state. (12)

6. (a) Discuss the functions of the Legislature in a state. (11½)
   (b) Describe the role of opposition political party in parliamentary government. (12)

7. (a) What is local government? Discuss the functions of urban local government institutions in Bangladesh. (11½)
   (b) Analyze the determinants of Bangladesh foreign policy. (12)

8. Write short notes on any three (3) of the following: (23½)
   (a) Political sovereignty
   (b) Ideal type of bureaucracy
   (c) Surplus value theory
   (d) Good governance
SECTION - A

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

1. (a) A company is setting up an assembly line to produce 1920 units per 8-hour shift. The following table identifies the work elements, times, and immediate predecessors:

<table>
<thead>
<tr>
<th>Work Elements</th>
<th>Times (Sec)</th>
<th>Immediate Predecessors</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4</td>
<td>None</td>
</tr>
<tr>
<td>B</td>
<td>8</td>
<td>A</td>
</tr>
<tr>
<td>C</td>
<td>6</td>
<td>D, E, F</td>
</tr>
<tr>
<td>D</td>
<td>3</td>
<td>B</td>
</tr>
<tr>
<td>E</td>
<td>2.5</td>
<td>B</td>
</tr>
<tr>
<td>F</td>
<td>1.5</td>
<td>B</td>
</tr>
<tr>
<td>G</td>
<td>12</td>
<td>A</td>
</tr>
<tr>
<td>H</td>
<td>14.5</td>
<td>G</td>
</tr>
<tr>
<td>I</td>
<td>13</td>
<td>H</td>
</tr>
<tr>
<td>J</td>
<td>11.5</td>
<td>C, I</td>
</tr>
</tbody>
</table>

(i) Draw a neat precedence diagram.
(ii) Calculate cycle time.
(iii) Calculate theoretical minimum number of workstations.
(iv) Assign task using longest operating time.
(v) Calculate the total idle time.
(vi) Calculate efficiency of the balanced line.

(b) Discuss the main differences between product and process layouts.

(c) Explain the following diagram.
2. (a) Mina works as a sales manager for a toy manufacturer, and she currently has six salespeople on the road meeting buyers. Mina's salespeople are in Chittagong, Jessore, Rajshahi, Dinajpur, Khulna, and Sylhet. Mina wants them to travel to six other cities: Comilla, Chandpur, Rangamati, Rangpur, Moulovi Bazar, and Barishal. Table below shows the bus ticket price between cities.

<table>
<thead>
<tr>
<th>Salespeople in cities</th>
<th>Cities salespeople have to travel to</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Comilla</td>
</tr>
<tr>
<td>Chittagong</td>
<td>650</td>
</tr>
<tr>
<td>Jessore</td>
<td>300</td>
</tr>
<tr>
<td>Rajshahi</td>
<td>750</td>
</tr>
<tr>
<td>Dinajpur</td>
<td>600</td>
</tr>
<tr>
<td>Khulna</td>
<td>900</td>
</tr>
<tr>
<td>Sylhet</td>
<td>1450</td>
</tr>
</tbody>
</table>

Where should Mina send each of the salespeople in order to minimize the traveling cost?

(b) Discuss the following concepts from Henry Fayol’s 14th principles of management.

(i) Discipline
(ii) Equity
(iii) Scalar chain
(iv) Initiative

(c) What was the main contribution of the "Hawthorne Studies" to the domain of management knowledge?

3. (a) Explain Group Behaviour Model

Contd ........... P/3
(b) Friends, Inc., distributes a high-quality wooden dollhouse that sells for $20 per unit. Variable costs are $8 per unit, and fixed costs total $180,000 per year.

(i) What is the product's CM ratio?

(ii) Use the CM ratio to determine the break-even point in sales dollars.

(iii) Due to an increase in demand, the company estimates that sales will increase by $75,000 during the next year. By how much should net operating income increase (or net loss decrease) assuming that fixed costs do not change?

(iv) Compute the degree of operating leverage at the current level of sales assuming that the operating results for last year were:

<table>
<thead>
<tr>
<th>Sales</th>
<th>$400,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less Variable Expenses</td>
<td>$160,000</td>
</tr>
<tr>
<td>Contribution Margin</td>
<td>$240,000</td>
</tr>
<tr>
<td>Less Fixed Expenses</td>
<td>$180,000</td>
</tr>
<tr>
<td>Net Operating Income</td>
<td>$60,000</td>
</tr>
</tbody>
</table>

(v) The president expects sales to increase by 20% next year. By what percentage should net operating income increase?

4. (a) You are choosing between two machines. Machine-1 cost $1,000 and machine-2 cost $600. The maintenance of machine-1 is expected to be $155 in the first and second years and will increase by $35 for the following seven years. The maintenance of machine-2 is expected to be $160 and will increase each year $55 for the following eight years.

(i) Draw the cash flow diagram for each machine.

(ii) Considering the lifecycle cost of machines, which machine should you purchase? Assume an interest rate of 8%.

(b) Which of the following factors are motivators and which are hygiene factors? Justify your answer for all the factors with suitable examples.

(i) growth (ii) status (iii) recognition (iv) salary (v) relationship with peers.

SECTION - B

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

5. (a) What is meant by performance appraisal? Mention the benefits of performance appraisal.

(b) Briefly describe 'Behaviorally Anchored Rating Scales' technique in performance appraisal.
(c) Suppose, you are working in a managerial post at a software development company. For the performance appraisal of one of your assistant programmers, you want his participation in the program. What type of appraisal method are you going to follow? Briefly describe the method and discuss about the advantages and disadvantages of this method.

(d) How can you explain the technology price relationship for telecommunication service in Bangladesh?

6. (a) In a factory, a worker is given to assemble 40 pieces of an electronic product. The standard task for assembling the product is 5 products/hr and Guaranteed base rate is 50 tk/hr. Low task would be 70% of the standard task. If the worker take 6.5 hrs to complete the given task, find the wage for the job and the rate of incentive per hour for the worker according to-

(i) Rowan Plan.
(ii) Bedeaux Plan.
(iii) Halsey Plan (Percentage of the workers' share in gain above the task is 35%).

(b) Describe the competitive forces that represents the market attractiveness according to Porter's five force model with relevant examples.

(c) What are the factors that affect consumer behavior in case of buying a mobile phone? Explain with examples.

7. (a) Suppose, you want to manufacture printer in your organization. What will be the components of cost of quality in this manufacturing process? Describe in brief. Explain, how the optimum cost of quality can be achieved with necessary figures.

(b) What are the purposes of using control charts? How can you decide a process is out-of-control from a control chart? Determine whether the following control chart is in-control or out of control and justify your answer.

(c) Why do we require management of technology? Discuss about the innovation cycle of computer.

Contd ......... P/5
8. (a) What is a business model? Discuss and compare between two different types of business models.
(b) What are the fundamental differences between traditional and contemporary theories of leadership?
(c) Explain with examples prime cost and conversion cost.
(d) Which cost is not relevant for decision making? Explain why it is not relevant.
### Compound Interest Tables

#### 8%

<table>
<thead>
<tr>
<th>Compound Interest Factors</th>
<th>Uniform Payment Series</th>
<th>Arithmetic Gradient</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P</strong></td>
<td><strong>A</strong></td>
<td><strong>G</strong></td>
</tr>
<tr>
<td><strong>P/A</strong></td>
<td><strong>A/P</strong></td>
<td><strong>G/P</strong></td>
</tr>
<tr>
<td>10%</td>
<td>7.396</td>
<td>5.034</td>
</tr>
<tr>
<td>20%</td>
<td>6.302</td>
<td>4.003</td>
</tr>
<tr>
<td>30%</td>
<td>5.403</td>
<td>3.004</td>
</tr>
<tr>
<td>40%</td>
<td>4.503</td>
<td>2.005</td>
</tr>
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</tr>
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<td>90%</td>
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<td>0.010</td>
</tr>
<tr>
<td>100%</td>
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</tr>
</tbody>
</table>

**Notes:**
- **P/A** = Present Value Factor
- **A/P** = Annuity Payment Factor
- **G/P** = Gradient Payment Factor

<table>
<thead>
<tr>
<th>Compound Interest Factors</th>
<th>Uniform Payment Series</th>
<th>Arithmetic Gradient</th>
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<tr>
<td><strong>P</strong></td>
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<td>4.003</td>
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<tr>
<td>100%</td>
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<td>0.011</td>
</tr>
</tbody>
</table>

**Notes:**
- **P/A** = Present Value Factor
- **A/P** = Annuity Payment Factor
- **G/P** = Gradient Payment Factor
1. (a) How do you model a machine translation program to translate a Bangla sentence to an English sentence using HMM? (10)
   (b) What are the different types of sensor used in an autonomous vehicle? How can you use Laser and Camera sensors to improve the driving experience? (5+5)
   (c) What do you mean by degree of freedom of a robot? When you plan a robot to perform a task, why do you switch between configuration space and coordinate space to perform the task? (2+3)
   (d) Given the following Bayes Net:

\[ \begin{align*}
&L \rightarrow R \quad B \\
&L \rightarrow T \\
&T \rightarrow T' \\
\end{align*} \]

Answer whether the following independence statements are true.
   (i) \( L \perp T' | T \) (ii) \( L \perp B \) (iii) \( L \perp B | T \) (iv) \( L \perp B | T' \) (v) \( L \perp B | T, R \) (10)

2. (a) How do you update your weights for the Perceptron based binary classification? (5)
   (b) For a bag-of-words model based spam-nonspam email naive Bayes classification problem, what are the parameters you need to learn and how do you answer the spam/nonspam query? (10)
   (c) What is Laplace smoothing and how do you determine the smooth parameter (k) while designing your leaning algorithm? (8)

Contd ........... P/2
(d) Consider a dataset with two Boolean attributes (A, B). The dataset consists of 203 examples labeled with + and − outputs.

\[
\begin{align*}
\langle A = 0, B = 0 \rangle, − & : 50 \text{ examples} \\
\langle A = 0, B = 1 \rangle, − & : 50 \text{ examples} \\
\langle A = 1, B = 0 \rangle, − & : 3 \text{ examples} \\
\langle A = 1, B = 1 \rangle, + & : 100 \text{ examples}
\end{align*}
\]

Based on the information gain concept, draw the decision tree. Also show the calculation of information gain at each step of the tree construction.

3. (a) How do you compute the posterior probability \( P(X_k | e_1, \ldots, e_t) \) of a past state \( X_k \) for a given set of evidence \( e_1, e_2, \ldots, e_t \), where \( t > k \)?
(b) How do you compute \( P(E | j, m) \) by using variable elimination method for the following Bayes Net?

```
B

\|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|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SECTION – B
There are FOUR questions in this section. Answer any THREE.

5. (a) What are the four approaches of Artificial Intelligence (AI)? What is the "laws of thought" approach? What are the main obstacles to this approach? (4+4+4=12)
(b) Distinguish between the Turning test and the total Turning test. Show how the skills needed to pass the Turning test allow an agent to act rationally. What are the main advantages of the rational agent approach of AI? (6+4+4=14)
(c) How can you relate the following disciplines to the foundations of AI?
   (i) Mathematics (ii) Economics (iii) Control theory and cybernetics (9)

6. (a) Why is the iterative deepening search the preferred uninformed search method when the search space is large and the depth of the solution is unknown? What is the main difference between the informed search and the uninformed search strategies? (10)
(b) Prove each of the following statements:
   (i) Breadth-first search is a special case of uniform-cost search.
   (ii) Breadth-first search, depth-first search, and uniform-cost search are special cases of best-first search.
   (iii) Uniform-cost search is a special case of A* search.
(c) The heuristic path algorithm is a best-first search in which the evaluation function is \( f(n) = (2-w)g(n) + wh(n) \). For what values of \( w \), this algorithm is guaranteed to be optimal (you may assume that \( h \) is admissible). What kind of search does this perform for the following cases:
   (i) \( w = 0 \) (ii) \( w = 1 \) (iii) \( w = 2 \) (13)

7. (a) Prove that the A* search is optimal. (10)
(b) Explain how admissible heuristics can be generated from relaxed problems for the 8-puzzle problem. Can you generate an admissible heuristic from each of the relaxed problems which you have described? (10)
(c) Describe the algorithm to calculate the Linear Conflict (LC) heuristic for the 15-puzzle problem using pseudocode. What is the LC heuristic value for the following puzzle (assuming the standard goal state)? (15)

```
3 2 1 B
10 9 7 13
8 5 11 15
6 12 14 4
```

Here 'B' refers to the blank tile.

Contd ........... P/4
8. (a) Distinguish between the variable and value ordering heuristic by providing one illustrative example for each case for the map coloring problem.
(b) How can you formally define a game as a kind of search problem? What is a game tree?
(c) Why is move-ordering significant for the effectiveness of $\alpha$-$\beta$ pruning? What is a Killer move?
(b) What are the reasons for the hill-climbing search to get stuck or face difficulty in obtaining the global optimum solution? What is a sideways move?
1. (a) Derive an acceptance-rejection method for generating beta(4,1) random variables. The density function of beta(4,1) is $f(x) = 4x^3$, $0 \leq x \leq 1$; which is plotted in Figure 1. You cannot use any majorizing function in the form of $t(x) = c$, $0 \leq x \leq 1$. You should also discuss how you would generate random variables having density $r(x) = t(x)/c$. How many U(0,1) random numbers you need, on an average, to generate each single variate in this approach?

(b) Explain the Box-Muller method to generate standard normal random variates. Illustrate with necessary figures.

(c) Give inverse-transform method for generating random variates with-

(i) Density function, $f(x) = \begin{cases} x^2, & 0 \leq x \leq 1 \\ 1, & 1 < x \leq \frac{5}{3} \end{cases}$

(ii) Mass function, $p(i) = \frac{3 - |i - 3|}{9}$, for $i = 1, 2, 3, 4, 5$

2. (a) Give a composition algorithm for generating random variates having the density function shown in Figure 2.
(b) Describe the *serial test* for testing random-number generators. Which properties of random numbers are tested by this test? \(\text{(8+2=10)}\)

(c) What are Prime Modulus Multiplicative LCGs (PMMLCGs)? What are the benefits of them? Explain how the simulated division technique can be used to avoid explicit division for implementing PMMLCGs. \(\text{(3+3+4=10)}\)

3. (a) Answer the following questions regarding various probability distributions. \(\text{(3+3+4=10)}\)
   
   (i) Let \(X_1 \sim \text{gamma} (\alpha_1, \beta), X_2 \sim \text{gamma} (\alpha_2, \beta), X_3 \sim \text{gamma} (\alpha_3, \beta)\). What is the distribution of \(X_1 + X_2 + X_3\)?

   (ii) Let \(X \sim \text{LN}(\mu, \sigma^2)\). How can you obtain \(Y \sim \text{N}(\mu, \sigma^2)\) from \(X\)?

   (iii) What are the relationships between Weibull and exponential distribution?

(b) When do we call a chi-square test unbiased? For a chi-square test with equiprobable intervals, derive an expression for the interval end-points. \(\text{(2+8=10)}\)

(c) What is box plot? Briefly discuss how box plots help in hypothesizing distribution family of the observed data. \(\text{(2+6=8)}\)

(d) Do you agree with the statement- "A full-period LCG can generate all possible rational numbers in the interval \([0, 1]\)? Justify your position. Show that the average of the \(U_i\)'s taken over an entire cycle of a full-period LCG is \(\frac{1}{2} \cdot \frac{1}{2m} \cdot \frac{1}{2}\). \(\text{(3+4=7)}\)

4. (a) Compute the Kolmogorov-Smirnov (K-S) test statistic for the following five ordered data points against hypothesized \(\text{U}(0, 10)\) distribution: \(\text{1.5, 5, 6, 7.5, 9}\) \(\text{(10)}\)

(b) For an exponential distribution with parameter \(\beta\), derive a Maximum Likelihood Estimator (MLE) for \(\beta\) given IID data \(X_1, X_2, \ldots, X_n\). \(\text{(10)}\)

(c) What do P-P plot and Q-Q plot mean? Briefly describe how they are useful in determining the goodness of the fitted distribution compared to observed data points. \(\text{(3+5=8)}\)

(d) Describe the technique to construct an empirical distribution when the observed data are grouped. \(\text{(7)}\)
5. (a) Describe the Multiteller Bank with Jockeying model. Draw the event graph. Identify the random streams. Describe the arrival and departure functions using flowcharts.

(b) Describe how you can estimate the value of the mathematical constant \( \pi \) (pi) using Monte Carlo simulation technique.

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6. (a) Suppose \( X \) and \( Y \) are random variables such that \( Y = aX + b \). Here \( a \), and \( b \) are constants. Show that the correlation of \( X \) and \( Y \) equals 1 if \( a > 0 \), and -1 if \( a < 0 \).

(b) “Uncorrelated random variables are not necessarily independent.” – Demonstrate with an example.

(c) Suppose \( X \) and \( Y \) are jointly discrete random variables with

\[
p(x, y) = \begin{cases} \frac{xy}{27} & \text{for } x = 1, 2 \text{ and } y = 2, 3, 4 \\ 0 & \text{otherwise} \end{cases}
\]

Prove that \( X \) and \( Y \) are independent.

7. (a) Suppose that 7.3, 6.1, 3.8, 8.4, 6.9, 7.1, 5.3, 8.2, 4.9, and 5.8 are 10 observations from a distribution (not highly skewed) with an unknown mean \( \mu \). Compute \( \bar{X}(10) \), \( S^2(10) \), and an approximate 90% confidence interval for \( \mu \), assuming \( t_{0.095} = 1.83 \).

Also, test the null hypothesis \( H_0 : \mu = 6 \), at level \( \alpha = 0.10 \). Here the symbols carry their usual meaning.

(b) How can you generate an exponential random variable using a uniform random variable? Prove the correctness of your proposed technique.

(c) Write down the properties of a covariance-stationary process.

8. (a) State and explain the central limit theorem. State the strong law of large numbers.

(b) Write short notes on the following topics:

(i) Continuous and discrete simulation models

(ii) Next-event and fixed-increment time advance mechanisms

(iii) Type I and type II errors in hypothesis testing.
SECTION – A

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

1. (a) State different types of sensor arrangements for image acquisition systems? Describe the one which is used in a CT/PET imaging system. How does this system differ from mask mode radiography? What are the issues one should care in mask mode radiography? How are they addressed? (3+8+8+3+5=27)

(b) Which coding method does JPEG use to truncate discrete cosine transform (DCT) coefficients? How does it differ from the other method? (8)

2. (a) Differentiate between lossless and lossy versions of the compression algorithms that encode the differences between consecutive pixels. Use the lossy version to compress the following image segment. Scan the image row wise to make it a 1D array.

\[
\begin{array}{cccc}
14 & 15 & 14 & 15 \\
13 & 15 & 15 & 14 \\
20 & 26 & 27 & 28 \\
\end{array}
\]

(7+13=20)

(b) An image contains zero gray level everywhere except a constant rectangle of size T×Z with gray level A. Find its Fourier transform in continuous domain. Draw the 1D cross section of its spectrum. Can you explain from this graph why an ideal low pass filter produces ringing effect? (8+2+5=15)

3. (a) The image formation model explains how grayscale values of an image are produced. How can you explain different frequency components of an image according to this model? Explain a filtering technique that treats low and high frequency components in different ways. (5+15=20)

(b) Explain the effect of rotation and translation of object in an image on its Fourier spectrum. Why do we perform element-by-element multiplication of spectrum matrix and filter matrix in frequency domain filtering? Why is the filter matrix called a transfer function? (8+3+4=15)

Contd .......... P/2
4. (a) What is the basic idea of image compression in frequency domain? A particular lossless image compression algorithm (i) assigns fixed length code to a variable sequence of source symbols and (ii) is used in pdf, tiff, gif files. Use this algorithm to compress the following image segment. 

   39 40 128 128  
   39 40 128 127  
   41 40 128 127  

(b) Define spatial and gray level resolution of an image. With necessary examples, explain how they are related to image digitization process. 

SECTION - B

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

5. (a) What do you understand by thresholding? Justify the statement "thresholding is a special case of contrast stretching" with necessary diagrams. 

(b) Why is gamma correction necessary? Explain the process of gamma correction. 

(c) Describe two ways of intensity-level slicing. 

6. (a) "Histogram equalization results in a random variable having uniform probability density function (PDF)" — explain with supporting mathematical background. 

(b) Illustrate the difference between correlation and convolution in regards to linear spatial filtering with an example. 

7. (a) Consider the following image strip with the given intensities:

   5 5 4 3 2 1 0 0 0 6 0 0 0 0 1 3 1 0 0 0 7 7 7 7

Find the first derivative and second derivative of the image strip. From these values indicate the portions which correspond to ramp, step, and isolated point with necessary explanation. 

(b) What are two salient features of the Laplacian of Gaussian (LoG) operator? Derive an expression for the LoG operator. 

8. (a) State the steps in the Polygonal Fitting-Algorithm.

(b) Given n points in an image, suppose that we want to find subsets of these points that lie on straight lines. Propose a solution having a time complexity O(n^3) to this problem. Now describe how Hough transform reduces the time complexity for this problem.
There are FOUR questions in this section. Answer any THREE.

1. (a) Draw all labeled trees of four vertices. Construct the tree corresponding to Prüfer's code 2, 3, 2, 6, 6, 5 showing every step. (5+10)
   (b) What is a perfect matching? Compute the number of perfect matchings in $K_n$. (2+3)
   (c) Show that a matching $M$ in a graph $G$ is a maximum matching if and only if $G$ has no $M$-augmenting path. (15)

2. (a) Describe an application of a connected dominating set in the area of computer networks. (5)
   (b) Define the diameter and the domination number of a graph. Establish a relationship between the domination number and the diameter of a graph. (4+8)
   (c) What is a tournament? Show that every tournament $T$ contains a Hamiltonian path. (2+8)
   (d) Give an example of a tree of six or more vertices whose center is an edge. Write an efficient algorithm for finding the center of a tree. (2+6)

3. (a) Define the chromatic number and the chromatic index of a graph with illustrative examples. Let $G$ be a bipartite graph with the maximum degree $\Delta$. Then prove that $\chi'(G) = \Delta$. (4+8)
   (b) Show that the number of separating triangles in a triangulated plane graph $G$ with $n$ vertices is at most $n - 4$. (8)
   (c) Define a tree decomposition of a graph with an illustrative example. What is the treewidth of a graph? Explain the importance of treewidth from algorithmic point of view. (5+2+3)
   (d) Construct a clique tree representation for the chordal graph in Figure 1. (5)

Figure 1: Figure for Question Number 3(d).
4. (a) Describe an application area where the notion of planar graphs is useful. Give an example of a planner graph which has an exponential number of planner embeddings.

(b) Let $G$ be a connected simple plane graph, and let $n$, $m$, and $f$ denote respectively the numbers of vertices, edges, and faces of $G$. Then prove that $n - m + f = 2$.

(c) Show that every maximal planar graph of four or more vertices has at least four vertices of degree five or less.

(d) Prove that every simple planar graph has a straight-line drawing. Write an algorithm for finding a straight-line drawing of a planar graph based on your proof.

5. (a) Consider the following graph of a floor with seven rooms in a building. A room is represented by a vertex, and the adjacency between two rooms is represented by an edge. Give the floor plan so that each room is drawn as a rectangle and the outer boundary is also drawn as a rectangle. Give the incidence matrix of the graph.

(b) Define compliment of a graph. Show that for any graph of six vertices, either the graph or its compliment contains a triangle.

(c) What is the necessary and sufficient condition for $K_{m,n}$ to be a regular graph?

(d) What is graph isomorphism? Are the following graphs $G_1$ and $G_2$ isomorphic? If they, show the mapping.
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6. (a) What is the cut-edge? Prove the statement that “An edge is a cut-edge if and only if it belongs to no cycle” \( (2+10=12) \)
(b) Prove the statement that “A graph G of three or more vertices is 2-connected if and only if there are two internally disjoint paths between every pair of vertices in G.” \( (15) \)
(c) Explain the Block-Cutvertex tree of a connected graph G with an example. \( (8) \)

7. (a) Define “Degree sequence” and “Graphic sequence”. Find the minimum value of \( x \) for which the sequence \((6, 5, x, 2, 2, 1, 1)\) becomes a graphic sequence. Also construct a simple graph with the sequence. \( (5+5+5=15) \)
(b) Let \( K_n \) be a complete graph of \( n \) vertices where \( n \) is odd and \( n \geq 3 \). Show that \( K_n \) has \((n-1)/2\) edge-disjoint Hamiltonian cycles. \( (10) \)
(c) Let \( \pi(G) \) be the number of spanning trees of a connected graph \( G \) and let \( e \) be an edge in \( G \). Show that \( \pi(G) = \pi(G-e) + \pi(G/e) \). If \( e \) is a cut edge, what is the value of \( \pi(G-e) \)? \( (10) \)

8. (a) Prove that a graph \( G \) has an ear decomposition if only if \( G \) is 2-connected. \( (15) \)
(b) What is union of graphs? Draw the graph \( G = (V, E) \) with vertex set \( V = \{a, b, c, d, e, f, g, h\} \) and edge set \( E = \{(a, b), (a, e), (b, c), (b, d), (c, d), (c, g), (d, e), (e, f), (f, g), (f, h), (g, h)\} \). Draw the graph \( G - (d, e) \). Draw the subgraph of \( G \) induced by \( \{c, d, e, f\} \). Contract the edge \( (d, e) \) from \( G \). \( (2\times5=10) \)
(c) Define each of the followings with examples:
   (i) \( k \)-regular Graph
   (ii) Petersen Graph
   (iii) Null Graph
   (iv) Path Graph
   (v) Wheel Graph.