

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
 B.Sc. Engineering 1st Year 1st Term Examination, 2023
 Department of Computer Science and Engineering
 CSE 1101
 Structured Programming

TIME: 3 hours

FULL MARKS: 210

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

SECTION A

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

1. a) What is cyclic property of data type in C language? Explain the output of the following C program. (10) [CO1]

```
int main() (
    unsigned char b = 80, c = 20, d = 2;
    unsigned char y = -400, z = 20, w = 30;
    unsigned char a = b*c/d;
    unsigned char x = y/z*w;
    printf("%d %d", a, x);
    return 0;
}
```

- b) Why 'goto' should be avoided? Why C is called structured programming language? (10) [CO1]
 c) Write a program to calculate the average of marks of x students based on N courses with necessary function design. The `main()` function only takes inputs and call user-defined functions. Design the functions in different `.c` files. (15) [CO2]
2. a) Which one is better between `else if` ladder and `switch` statement? Explain with example. (15) [CO1]
 b) You have an ancient vault that has treasures. The vault is secured with password of length 9 that contains lower case English characters and digits. Write the algorithm and draw the flowchart for checking the password of the vault. (15) [CO4]
 c) Differentiate between function prototyping and function definition. (05) [CO1]
3. a) Imagine you are developing software for a secured communication system. As a part of the encryption process. You need to generate a list of 'secured keys' within a range. A 'secured key' is defined as a number that has exactly two distinct factors. Write the C program to implement it. (15) [CO4]

- b)

```
int main()
{ int a, b;
  scanf("%d %d", &a, &b);
  add(); // returns a+b
}
```

 (10) [CO3]

	memory
memory space	variable 1
for variables	variable 2
memory space	pointer 1
for pointers	pointer 2

Consider the memory space available for variables and pointers. Now design the appropriate `add()` function.

- c) Write a program to calculate the sum of the following series for first n terms. (10) [CO2]
- $$\frac{1}{6} + \frac{1}{11} + \frac{1}{21} + \frac{1}{36} + \dots$$
4. a) Define recursion. Explain the basic Fibonacci problem using recursion for n th position Fibonacci number. (10) [CO3]
 b) How garbage collection can be handled in C? Can you optimize the `add()` function with fewer variables? (10) [CO3]
- ```
int a, b;
void add(int *c, int *d){printf("%d", *c+*d);}
int main(){add(&a, &b); return 0;}
```
- c) Write C program that multiplies two matrices if they are multipliable using `multiply()` function and returns the results. Consider taking dimension of the matrices from command line terminal. (15) [CO2]

## SECTION B

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

5. a) What is self-referential structure? Explain with coding example. (08) [CO1]  
b) How can we pass a structure pointer to a user defined function? Briefly describe with example. (09) [CO2]  
c) Design a C program that involves two structures, 'Date(day, month, year)' and 'StudentRecord(name, dateOfBirth(of type Date), totalMarks)'. (12) [CO2]  
i) Now, guess the basic data types and define the structures.  
ii) Take user inputs for the details of two students.  
iii) Write a user and defined function named 'calculateAgeDifference' which takes two students as input and returns their age difference based on their dateOfBirth as 'Date' object. (Assume, each month has 30 days).  
d) What is structure padding? How to avoid structure padding? Describe with proper example. (06) [CO2]
6. a) You are tasked with creating a program to sort students in the CSE2k22 class based on their roll numbers and final results. The CSE2k22 structure has int roll and float result. (20) [CO4]  
Now,  
i) Define the CSE2k22 structure.  
ii) Implement two custom comparison functions:  
• int compareRollAscending(const void\*, const void\*) – take two CSE2k22 object references and return their roll difference.  
• int compareResultDescending(const void\*, const void\*) – take two CSE2k22 object references and return their result difference.  
iii) Create a function  
void customSort (CSE2k22 \*matrix, int row, int col, int (\*compare)(const \*void, const \*void)) to sort the matrix of students.  
iv) Implement a function to display the CSE2k22 \*matrix.  
v) In the main function:  
• Create a 2x3 matrix of CSE2k22 students.  
• Sort the matrix based on roll and print the output.  
• Sort the matrix based on result and print the output.
- b) Differentiate between malloc and calloc. How can you resize a dynamically allocated memory space? (08) [CO1]  
c) In the following enumeration declaration, determine the value of each number by printing them. enum e{a = 10, b, c, d = -17, e = 5, f }; (07) [CO2]
7. a) Write a structure declaration for the following situations. Assume an 16-bit integer word. Define four-bit fields, a, b, c, and d, whose widths are 6 bits, 6 bits, 9 bits and 7 bits respectively. Force b to the beginning of the second word storage. Separate b and c with 10 vacant bits. (08) [CO2]  
b) What is the purpose of typedef feature? Explain the outputs of the following program. (08) [CO1]  

```
#include<stdio.h>
int main(){
 int a[10] = {-1};
 int *head = &a[0];
 int i;
 head++;
 for(i=0;i<9;i++){
 *head++=head[-1]+2;
 printf("head[-1] = %d, a[%d] = %d\n", head[-1],i,a[i]);
 }
 return 0;
}
```
- c) What is the difference between structure and union? How union works? Explain with a coding example. (07) [CO3]  
d) Write a program to split the strings into parts by delimiters like comma, space, dollar sign. (12) [CO4]
8. a) Write a C program that will take filename(s) as command line arguments, read the files and display the contents if they exist. Give proper explanation of your implementation. (11) [CO3]  
b) Write a program that will read text file "input.txt" and write each word (with max length 12) in reverse order in "output.txt". (12) [CO3]  
Sample input: Hellow ABC def Sample Output : olleH CBA fed.  
c) What are the advantages of fread() and fwrite() over fscanf() and fprintf()? Show examples. (12) [CO1]

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 CSE 1107

Discrete Mathematics

TIME: 3 hours

FULL MARKS: 210

- N.B. i) Answer **ANY THREE** questions from each section in separate scripts.  
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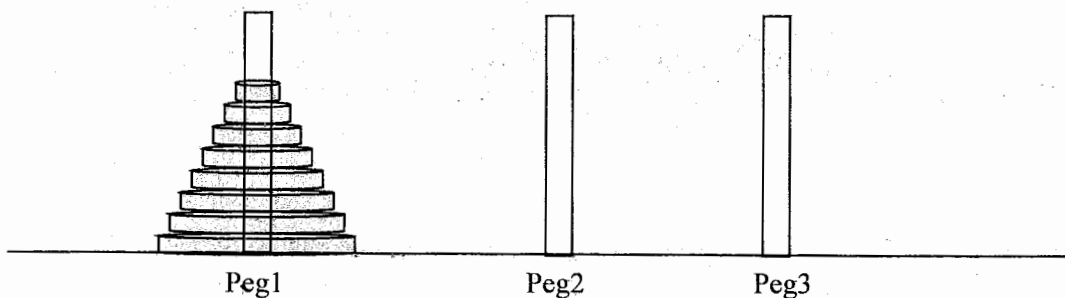
**SECTION A**

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

1. a) Explain “Contrapositive”, “Converse”, and “Inverse” logics using examples(s). (12) [CO1]
- b) Are  $\neg(P \vee Q)$  and  $\neg P \wedge \neg Q$  logically equivalent? Prove your answer using a truth table. (08) [CO2]
- c) A detective has interviewed four witnesses to a crime. From their statements, the detective (15) [CO4] has concluded that
  - i) If the butler is telling the truth, then so is the cook;
  - ii) The cook, and the gardener cannot both be telling the truth;
  - iii) If the handyman is telling the truth then the cook is lying.
  - iv) The gardener and the handyman are both not lying.

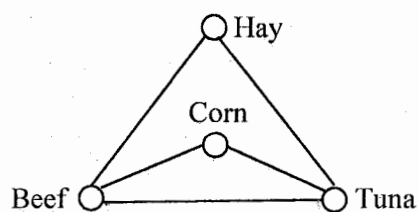
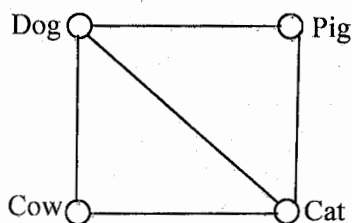
Now deduce who **MUST** be lying? (There may be more than one liar). Use Rules of inference for propositional logic.

2. a) Explain the idea of induction method. Use induction method to find the orderings of all (12) [CO2]  $n$ -bit strings in such a way that two consecutive bit strings differed by only one bit.
- b) A popular puzzle of the late nineteenth Century, called the Tower of Hanoi, consists of (15) [CO3] three pegs mounted on a board together with disks of different sizes. Initially these disks are placed on the first peg in order of size, with the largest one on the bottom.

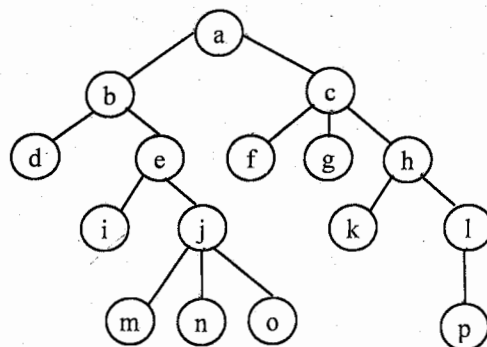


The rules of the puzzle allow disks to be moved one at a time from one peg to another as long as a disk is never placed on top of a smaller disk. The goal of the puzzle is to have all the disks on the second peg in order of size, with the largest on the bottom. Let  $H_n$  denote the number of moves needed to solve the Tower of Hanoi problem with  $n$  disks. Setup a recurrence relation for the sequence  $\{H_n\}$ . Hence, find the closed form of the solution.

- c) Draw the recursive Fibonacci evaluation tree for  $f(6)$ , where  $f(0) = 0$ ,  $f(1) = 1$ , and (08) [CO2]  $f(n) = f(n - 1) + f(n - 2)$ , for  $n = 2, 3, 4, 5, \dots$
3. a) What is a graph? Let  $G = (V, E)$  be a graph with directed edges. Then prove that (10) [CO1]  $\sum_{v \in V} \text{deg}^-(v) = \sum_{v \in V} \text{deg}^+(v) = |E|$ .
- b) What are the necessary and sufficient conditions for two graphs to be isomorphic? Are the (13) [CO4] following two graphs isomorphic? If so, explain.



- c) What is a rooted tree? Find the pre-order in-order and post-order traversal sequence results (12) [CO1]



4. a) What is linear congruential method? Use this method to find pseudo random members (10) [CO4] between the limit of 6 to 30.  
 b) Produce a secret message from the message "SEE YOU IN THE LOBBY" using the Caesar (15) [CO3] cipher method. Also decipher it.  
 c) Use Fermat's little theorem to find  $7^{121} \pmod{13}$ . (10) [CO2]

### SECTION B

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

5. a) What are the ways of proving set identities? Prove  $(B - A) \cup (C - A) = (B \cup C) - A$  (10) [CO1] using membership table.  
 b) In a class there is a set of 5 students  $S = \{Alice, Bob, Charlie, David, Emily\}$ . The relation (15) [CO4]  $R$  is defined as "having similar academic achievements in at least one subject." Now relation  $R$  is explained as following.
  - Alice has similar academic achievements with Bob and Charlie.
  - Bob has similar academic achievements with Alice and Charlie.
  - Charlie has similar academic achievements with Alice and Bob.
  - David has distinct academic achievements from Alice, Bob, Charlie, and Emily.
  - Everybody has similar academic achievements with themselves.
 Now, represent the relation using 0/1 matrix and also answer the following question.
  - i) is this relation "Equivalence relation" or "Partial Order relation" and why?
  - ii) Construct a Hasse diagram or show Equivalence classes which is applicable for this relation.
- c) Use the definition of " $f(x)$  is  $O(g(x))$ " to show that  $x^4 + 9x^3 + 4x + 7$  is  $O(x^4)$ . (10) [CO2]
6. a) Prove that  $[x] + [y] - [x + y] = 0$  or 1 whenever  $x$  and  $y$  are real numbers. (10) [CO1]  
 b) What is the coefficient of  $x^{11}y^{14}$  in the expansion of  $(5x - 6y)^{25}$ ? (05) [CO4]  
 c) How many ways are there to choose a dozen apples from a bushel containing 20 indistinguishable Delicious apples, 20 indistinguishable Macintosh apples, and 20 indistinguishable Granny Smith apples, if at least three of each kind must be chosen? (10) [CO2]  
 d) Determine how many integer solutions are there to  $x_1 + x_2 + x_3 + x_4 = 13$  if (10) [CO3]
  - i)  $0 \leq x_i$  for all  $1 \leq i \leq 4$ .
  - ii)  $0 \leq x_i \leq 7$  for all  $1 \leq i \leq 4$ .
7. a) Prove that the sequence  $\{a_n\}$  is a solution of the recurrence relation (10) [CO3]  
 $a_n = 2a_{n-1} - a_{n-2} + 2$  if  $a_n = n^2 - 3$ .  
 b) Solve the following linear non homogeneous recurrence relation (10) [CO4]  
 $a_n = 6a_{n-1} - 12a_{n-2} + 8a_{n-3} + 3$ , with initial condition  $a_0 = -5, a_1 = 4, a_2 = 88$ .  
 c) What are the conditions of an algebraic group? Show that the algebraic system  $G(Q^+, *)$  is (CO2) an abelian group; where  $Q^+$  is the set at all positive rational numbers and operation. "\*" is (15) defined as  $a * b = \frac{ab}{2}$  for all  $a, b \in Q^+$ .
8. a) Find the generating function of the sequence  $1, a, a^2, a^3, \dots$  (10) [CO1]  
 b) A young pair of rabbits is placed on an island. A pair of rabbits does not breed until they (15) [CO4] are 2 months old, each pair of rabbits produces another pair each month. Find a recurrence relation along with its closed form for the numbers of pairs of rabbits on the is-land after  $n$  months if all the rabbits are alive.  
 c) Consider the set  $Q$  of rational numbers, and let  $*$  be the operation on  $Q$  defined by (10) [CO2]  
 $a * b = a + b - ab$ .
  - i) Is  $(Q, *)$  a semigroup? Is it commutative?
  - ii) Find the identity element for  $*$ .

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY  
B.Sc. Engineering 1<sup>st</sup> Year 1<sup>st</sup> Term Examination, 2023  
Department of Computer Science and Engineering  
HUM 1107

English and Human Communication

TIME: 3 hours

FULL MARKS: 210

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

**SECTION A**

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

1. a) Make sentences on the following structures using the verbs given in brackets. (14) [CO1]
- i) Subject + Intransitive verb + adverbial of time. (go as verb).
  - ii) Subject + Linking verb + adjective complement. (prove as verb).
  - iii) Subject + Linking verb + noun complement. (prove as verb).
  - iv) Subject + Transitive verb + infinitive as object. (promise as verb).
  - v) Subject + Transitive verb + gerund as object. (enjoy as verb).
  - vi) Subject + Transitive verb + object + adjective complement. (believe as verb).
  - vii) Subject + Transitive verb + object + noun complement. (believe as verb).
- b) Change the following words as directed and make sentences with the changed words. (12) [CO2]  
Long (into noun); Opinion (into verb); Man (into adjective); Hate (into noun); Hate (into adjective); Reality (into adverb).
- c) Make words with the following prefixes and suffixes and use them in sentences: (09) [CO1]  
Arch....., ante....., quad....., .....en, .....se.
2. a) Transform the following sentences as directed. (14) [CO2]
- i) I cannot but yield to necessity. (Affirmative)
  - ii) You must obey your elders. (Negative)
  - iii) Nobody could ever count my love for you. (Interrogative)
  - iv) He is too busy to come here. (Complex)
  - v) He is too busy to come here. (Compound)
  - vi) Fakruddin is as clever as a fox. (Comparative)
  - vii) I am going to write a letter. (Passive)
- b) Make sentences using the following words as directed. (12) [CO1]  
But (as pronoun); But (as conjunction); Down (as adverb); Fast (as verb); Long (as verb); Like (as adjective).
- c) Make sentences using the following phrases and idioms: (09) [CO1]  
hang in there, call it a day, piece of cake, set on the fence, go down in flames, as right as rain.
3. a) Frame wh questions from the underlined parts of the following sentences. (14) [CO2]
- i) The boy went to the manager.
  - ii) This is Amin's book.
  - iii) My father is a school teacher.
  - iv) He reads the book for pleasure.
  - v) My father visited America last year.
  - vi) I reside in a poor cottage.
  - vii) The tower is hundred feet high.
- b) Make sentences using the following Modals as directed. (12) [CO2]
- i) May (To guess about the present).
  - ii) Could (To express inference).
  - iii) Must (To express logical deduction).
  - iv) Be to (To express command).
  - v) Need (To express unnecessary action in the past).
  - vi) Be going to (To express intention).
- c) Rewrite the following sentences using the right form of verbs. (09) [CO1]
- i) Health should be (take) care of.
  - ii) I went to bed (learn) my lessons.
  - iii) The principal wanted the notice to (hang).
  - iv) He (go) to start a business.
  - v) He has (come) home yesterday.
  - vi) At that time, I (sleep) in my room.

4. a) Complete the sentences with subordinate clauses: (14) [CO1]
- I don't know ..... (Noun clause)
  - She will give ..... (Noun clause)
  - The people ..... are my neighbors. (Adj clause)
  - They entered the shop ..... (Adj clause)
  - Hasna did all the cooking ... (Adv clause of reason)
  - He laughed ..... (Adv clause of manner)
  - It rained so hard ..... (Adv of result)
- b) Make sentences expressing the following notions/emotions. (12) [CO1]  
 (i) Annoyance, (ii) Approval, (iii) Condolence, (iv) Imprecation, (v) Regret, (vi) Wish.
- c) Supply a suitable word to fill up the gaps. (09) [CO1]
- Have you ever ..... to London?
  - Would you mind ..... a cup of tea?
  - ..... had I reached the station than the train left.
  - Hurry up ..... you should miss the train.
  - I am sorry for keeping you ..... outside.
  - ..... is believing.

### SECTION B

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

5. a) Read the passage and answer the following questions: (20) [CO2]
- For ten years Jack had spent his days sitting, kneeling or squatting on floors of different places to fit carpets. He cut and fit carpets for people to walk, but nobody ever noticed or appreciated it. Nobody ever said "Oh, that's a beautiful job". They just walked all over it. Jack was sick of it. He was just cutting and fixing the last edge on a huge red carpet in the living room of Mrs. Stephen. Rich Mrs. Stephen changed her carpets every year, and always bought the best. Rich Mrs. Stephen had never even given him a cup of tea all day and made him go outside when he wanted to smoke. It was four o'clock and he had nearly finished. At least he would be able to get home early today. He began to day-dream about the weekend, about the Saturday football game and so on. Jack sat back and finished his job. It was time for a last cigarette. He began tapping the pockets, looking for his Marlboro, but they were not there. As he swung around, he saw the lump in the middle of the brand new red carpet. A very visible one, the size of a packet of cigarettes. Jack got angry. He has done this once before, and taking up and refitting the carpet took him two hours. He was determined not to spend another two hours in this house. He decided to get rid of the lump by wasting a packet of cigarettes nearly full, but anything was better than taking up the whole carpet and refitting it. He took a block of wood and placed it on the lump. He then took a large hammer and without damaging the carpet, he began to beat the wood as hard as possible. He kept beating, hoping Mrs. Stephen wouldn't hear the noise and come to see. It would be difficult to explain why he was hammering the middle of her new carpet. After five minutes, he judged that the lump was almost invisible. Clearing up his tools, he carefully placed a coffee table over the place of the lump so that no one would see the spot where his cigarettes had been lost. Finally, he called Mrs. Stephen to inspect his work. "Yes, dear, very nice. You'll be sending me a bill, then?" "Yes madam" while Jack picked up his tool and walked out to his van, the lady said "Young man, while you were working today, you didn't see my Armand, a beautiful bird, did you?" "No, madam, I haven't seen" As Jack started his van, he saw his Marlboro on the dash board. He now remembered the lump and realized what it was. He remembered the hammering and began to feel rather sick.
- Describe Mrs. Stephen.
  - Why was Jack sick of his work?
  - How did Jack realize that the lump was not his Marlboro?
  - Jack didn't remove the carpet to take out the thing causing the lump. What would you do if you were in his situation?
- b) Make a precis of the above passage with a title. (15) [CO2]
6. a) Amplify the idea contained in the following statement. (20) [CO2]  
 Of soup and love first is the best.
- b) Write a contrast paragraph between video chat etiquette vs. in-person meeting etiquette. (15) [CO2]
7. a) Suppose Google is looking for a Cybersecurity threat analyst. Prepare your CV and apply for the post. (20) [CO2]
- b) Write a memo to your company staff informing them about a new policy "Overtime allowances" (15) [CO2]
8. a) Write a free composition on any one of the following. (35) [CO2]
- Political unrest: Its impact on our national growth.
  - A villain character from a book or a movie.

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY  
B.Sc. Engineering 1<sup>st</sup> Year 1<sup>st</sup> Term Examination, 2023  
Department of Computer Science and Engineering  
MATH 1107

Differential and Integral Calculus

TIME: 3 hours

FULL MARKS: 210

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

**SECTION A**

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

1. a) Define continuity and differentiability of a function. A function  $f(x)$  is defined as (14) [CO2] follows:

$$f(x) = 2 - x \text{ for } 1 \leq x \leq 2 \\ = x - \frac{1}{2}x^2 \text{ for } x > 2$$

Discuss the continuity and differentiability of  $f(x)$  at  $x = 2$ .

- b) Define subtangent and subnormal. Show that at any point of the curve (10) [CO1]  $x^{m+n} = k^{m-n}y^{2n}$ , the  $m^{\text{th}}$  power of the subtangent varies as the  $n^{\text{th}}$  power of the subnormal.
- c) State Rolle's theorem. Justify Rolle's theorem for the function  $f(x) = \ln\left(\frac{x^2+3}{4x}\right)$  in the (11) [CO3] interval (1, 3).
2. a) State Leibnitz's theorem. If  $y = (\sin^{-1} x)^2$ , then show that: (13) [CO2]  
i)  $(1 - x^2)y_2 - xy_1 - 2 = 0$ .  
ii)  $(1 - x^2)y_{n+2} - (2n + 1)xy_{n+1} - n^2y_n = 0$ .
- b) A particle is moving in a line. Its distance  $x$  cm from a fixed point  $O$  at any time  $t$  sec (12) [CO3] is given by the relation  $x = t^4 - 10t^3 + 24t^2 + 36t + 12$ . When is it moving most slowly?
- c) If  $y = x^{\tan x} + (\sin x)^{\cos x}$ , then find  $\frac{dy}{dx}$ . (10) [CO2]
3. a) Define tangent and normal. If  $x \cos \alpha + y \sin \alpha = p$  touch the curve  $\frac{x^m}{a^m} + \frac{y^m}{b^m} = 1$ , (13) [CO1] then show that  $(a \cos \alpha)^{\frac{m}{m-1}} + (b \sin \alpha)^{\frac{m}{m-1}} = p^{\frac{m}{m-1}}$ .
- b) Define asymptotes. Prove that the asymptotes of the cubic (12) [CO1]  $(x^2 - y^2)y - 2ay^2 + 5x - 7 = 0$  form triangle of area  $a^2$ .
- c) Evaluate  $\lim_{x \rightarrow 0} \left\{ \frac{1}{x^2} - \frac{1}{\sin^2 x} \right\}$ . (10) [CO3]
4. a) State Euler's theorem. If  $u = f(x^2 + 2yz, y^2 + 2zx)$  then prove that (12) [CO1]  $(y^2 - zx) \frac{\partial u}{\partial x} + (x^2 - yz) \frac{\partial u}{\partial y} + (z^2 - xy) \frac{\partial u}{\partial z} = 0$ .
- b) Define radius of curvature. Show that for the curve  $r^m = a^m \cos m\theta$  the radius of (13) [CO3] curvature is  $\rho = \frac{a^m}{(m+1)r^{m-1}}$ .
- c) State Taylor's theorem. Expand  $f(x) = x^4 - 10x^3 + 2x^2 - 3x + 10$  in a Taylor's (10) [CO3] series in power  $(x - 1)$ .

**SECTION B**

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

5. a) Suppose a particle moves along the coordinates axis, so that its velocity at a time  $t$  is (13) [CO3]  $v(t) = \frac{\cos t}{\sin^3(t)+1}$ , determine the displacement  $s(t)$  of the particle at time  $t$ .
- b) Evaluate  $\int \frac{dx}{x^{3/2}(2+3x)^{1/2}}$ . (10) [CO1]
- c) Integrate  $\int \frac{dx}{13+3 \cos x+4 \sin x}$ . (12) [CO1]

6. a) Evaluate  $\lim_{n \rightarrow \infty} \left\{ \left(1 + \frac{1}{n^2}\right)^{\frac{2}{n^2}} \left(1 + \frac{2^2}{n^2}\right)^{\frac{4}{n^2}} \left(1 + \frac{3^2}{n^2}\right)^{\frac{6}{n^2}} \cdots \left(1 + \frac{n^2}{n^2}\right)^{\frac{2n}{n^2}} \right\}$ . (11) [CO2]
- b) Evaluate  $\int_0^{\frac{\pi}{2}} \ln(\tan x + \cot x) dx$ . (12) [CO2]
- c) Evaluate  $\int_0^{\frac{\pi}{2}} \frac{\sin^2 x}{1 + \sin x \cos x} dx$ . (12) [CO2]
7. a) Define Beta and Gamma functions. Prove that  $\beta(m, n) = \frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}$ . Also prove that  $\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$ . (13) [CO1]
- b) Obtain the reduction formula for  $\int_0^{\frac{\pi}{2}} \sin^m x \cos^n x dx$ , hence evaluate  $\int_0^{\frac{\pi}{2}} \sin^4 x \cos^5 x dx$ . (12) [CO2]
- c) Show that  $\int_0^{\infty} \frac{x dx}{(x^2+1)(x^2+4)} = \frac{\ln 2}{3}$ . (10) [CO2]
8. a) Use the transformation  $u = x - y, v = x + y$  to evaluate  $\iint_R (x - y)^2 \cos(x + y) dA$ , (12) [CO3]  
 where  $R$  is the region enclosed by the square with vertices  $(0, 1), (1, 2), (2, 1),$  and  $(1, 0)$ .
- b) Evaluate  $\iiint_R (x + y + z) dx dy dz$  over the tetrahedron bounded by the planes  $x = 0, y = 0, z = 0$  and  $x + y + z = 2$ . (10) [CO3]
- c) A cable is hanged between two poles of equal height of 15m that are 20m apart. The sag of the middle point is 5m. Find its length when it forms a catenary. (10) [CO3]
- d) State Walli's formula. (03) [CO1]

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY  
B.Sc. Engineering 1<sup>st</sup> Year 1<sup>st</sup> Term Examination, 2023  
Department of Computer Science and Engineering  
PHY 1107  
Physics

TIME: 3 hours

FULL MARKS: 210

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

**SECTION A**

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

1. a) What are degrees of freedom? Using the law of equipartition of energy, show that for a gas possessing  $f$  degrees of freedom, the ratio of two specific heats ( $\gamma$ ) is  $(1 + \frac{2}{f})$ . (15) [CO1]  
Estimate the values of  $\gamma$  for monatomic, diatomic, and polyatomic gases.  
b) Give applications of the first law to: (10) [CO2]
  - i) isobaric,
  - ii) adiabatic,
  - iii) isothermal, and
  - iv) isochoric process.
- c) 1 gram of water at 20°C is converted into ice at -10°C at constant pressure. Heat capacity at 1 gm of water is 4.2 J/g.K and that of ice is 2.1 J/g.K. Heat of fusion of ice at 0°C = 335 J/g. Calculate the total change in the entropy of the system. (10) [CO3]
2. a) What is forced vibration? Show that the maximum displacement ( $A_{max}$ ) in the driven oscillator is inversely proportional to the damping constant ( $\lambda$ ). (10) [CO1]  
b) Examine the resultant of two simple harmonic motions of equal periods but different phase and amplitude when they act at right angles to each other. Analytically discuss the different important cases with appropriate diagram. (15) [CO2]  
c) If the quality factor of a sonometer wire of frequency 300 cps be  $2 \times 10^3$ , in what time will its energy be reduced to  $\frac{1}{e^{th}}$  of its energy in the absence of damping? (10) [CO1]
3. a) Distinguish between phase velocity and group velocity. Obtain a mathematical relation between them. (10) [CO2]  
b) Illustrate that the average power dissipation of a damped harmonic oscillator is  $-\frac{dE}{dt} = 2\lambda E$ , where the symbols have their usual meanings. (15) [CO2]  
c) The force and displacement of a simple dynamic system undergoing sinusoidal excitation are given by the equations  $F = 10 \sin(\frac{\pi t}{10})$  Newtons and  $Y = 0.1 \sin(\frac{\pi t}{10} - \frac{\pi}{3})$  meters. Calculate:
  - i) Work done in 20 seconds.
  - ii) Work done in 2.5 minutes.(10) [CO3]
4. a) Compare four-level and three-level laser scheme. Briefly explain why two-level laser scheme is not possible. (12) [CO1]  
b) What is meant by stimulated emission? Describe the construction and working principle of Ruby LASER. (15) [CO2]  
c) Find the relative population of the two states in a ruby laser that produces a light beam of wavelength 6938 Å at 27°C. (08) [CO4]

**SECTION B**

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

5. a) Explain the terms 'plank's quantum theory' and 'wave particle duality'. (10) [CO2]  
b) Derive an expression for Compton shift and explain the reason how it supports the concept of photon. (15) [CO4]  
c) An X-ray of photon of wavelength 0.29 Å undergoes a 60° Compton scattering. Calculate the frequency of scattered photon and the kinetic energy imparted to the recoiling electron. (10) [CO3]

6. a) Write short notes on: (12) [CO1]
- Uncertainty principle.
  - Pauli's exclusion principle.
  - Magnetic moment of an electron.
- b) Describe De-Broglie's concept of matter waves. Obtain the mathematical expression (13) [CO2] for the De-Broglie wavelength of matter waves.
- c) An electron of charge ' $e$ ' and mass ' $m$ ' moving around the nucleus in a circular path of (10) [CO3] radius ' $r$ ' and its angular momentum is ' $L$ '.
- Describe the expression for the orbital magnetic moment, and
  - Calculate the magnetic moment of the electron in Bohr magneton with angular momentum  $3 \hbar$ .
7. a) State eigen function, eigen value and eigen state. Calculate the eigenvalue (08) [CO2] corresponding to the wave function  $\psi = e^{2mx}$  and the operator  $\hat{A} = \frac{d^2}{dx^2}$ .
- b) Write down the properties of wave function. Deduce time-dependent Schrodinger (13) [CO1] equation in three dimensions.
- c) A particle with wave function  $\psi = \sqrt{\frac{2}{A}} \sin\left(\frac{\pi x}{A}\right)$  in  $0 \leq x \leq A$ , then (14) [CO4]
- Classify that the wave function is normalized or not.
  - Calculate the expectation value of  $x$ .
8. a) State Huygen's principle and prove the laws of reflection and refraction applying (12) [CO3] Huygen's principle.
- b) Explain the formation of Newton's rings. How can these be used to determine the (13) [CO2] wavelength of Sodium light?
- c) In Newton's ring experiment, the diameter of the  $n^{th}$  and  $(n + 6)^{th}$  bright rings are (10) [CO3] 4.2 mm and 7.0 mm respectively. Radius of the curvature of lower surface of the lens is 2 m. Calculate the wavelength of the light.