



**Course: CS101: Problem Solving using Imperative Programming**

**Class: F.E Engineering, Sem I**

**Branches: Comp/IT/ETRX/EXTC**

**Academic Year: 2020-21**

**PSIP Practice Questions**

**I. CONTROL STRUCTURES**

**Problem Set:**

1. Write a program which inputs N followed by the prices of N items. The program should output the price at which each item is offered in a sale. The sale price is calculated as follows. The original price is reduced by 10%, the resulting quantity raised to the nearest pound and then 1 penny subtracted from it. If the resulting quantity is less than the original price then the new price is output, otherwise the old price is output together with a warning message.

2. Write a program which inputs N followed by N pairs of numbers. The first of each pair represents the price of an item on a menu, the second the quantity eaten by a customer. The restaurant imposes a 10% service charge. The output from your program should itemized bill.

3. Write a program which reads in a time (t) being the earliest time at which a passenger can arrive at his departure railway station, and a number (m) being the longest journey time in hours that he is prepared to tolerate. The program then reads N followed by N pairs of numbers being the departure and arrival times of N trains to the passenger's destination. Print out the departure time of his most suitable train( that arriving earliest at his destination).

4. An aeroplane flying over a flat earth follows a course consisting of straight line segments connected together. Each segment has its own speed(in km/hour), duration(in minutes) and heading( a certain number of degrees East of North).

Write a program which reads in the details of a flight (as N followed by N triples) and calculates the co-ordinates of the aircraft at the end of the flight taking its starting position as (0,0).

5. In a certain country, Salex Tax is charged on cars at the following rate:

Net Price	Rate
<\$2000	15%
\$2000-\$3000	\$300 (flat rate)
>\$3000	10%

Write a program which prints out net price, Sales Tax and gross price for net prices between \$1000 and \$4000 in steps of \$250.

6. A bank wishes to detect a number of counterfeit cheques which are in circulation. On each cheque 2 numbers are printed, the cheque number and the account number. On all the counterfeit cheques the check number lies in the range 10000-10010. Write a program which reads the numbers taken from a batch of cheques and prints out for each cheque the cheque number and the account number followed by 999 if the cheque is possibly counterfeit. After the last pair of

numbers in the data is the integer-1.

7. Politicians and bankers often quote “the rule of 72” which says that if the annual rate of inflation is  $R\%$  then a fixed sum of money will decline in value by half in a period of  $72/R$  years. Test the accuracy of this rule by tabulating, for each value of  $k$  from 1 to 36

i)  $k$

ii) the value of  $72/k$

iii) the time at which the value of a sum is actually halved when inflation is  $k\%$ .

Assume that prices increase only once a year.

## II. FUNCTIONS AND RECURSION

### Problem Set:

1. A partition of the integer  $N$  is a collection of positive integers whose sum is  $N$ . The partitions of 4 can be written as:

4  
3 1  
2 2  
2 1 1  
1 1 1 1

2. On a conventional dartboard, a single dart may score any integer  $i$  in the range 1 to 20 also  $2*i$ ,  $3*i$ , 25 or 50.

a. Write a procedure which takes a single parameter  $N$  and determines whether or not  $N$  can be scored with 3 or fewer darts.

b. Modify your procedure so that it outputs the minimum no. of darts needed to score  $N$ .

3. The decimal expansion of the fraction  $1/p$  where  $p$  is some odd prime integer, will be recurring or equivalently repeating. The sequence of digits will start to repeat after at most  $(p-1)$  digits; the length of the repeating block is called the period of the infinite repeating decimal. Design a procedure which, given an odd prime  $p$ , determines the period of the decimal expansion of  $1/p$ .

4. Sort the given elements Ex:9,7,6,15,17,5,10,11 using insertion sort in a recursive way.

5. Find the number of ways that a given integer,  $X$ , can be expressed as the sum of the  $N^{\text{th}}$  powers of unique, natural numbers. For example, if  $X=13$  and  $N=2$ , we have to find all combinations of unique squares adding up to 13. The only solution is  $2^2 + 3^2$

6. Take two strings as input and then append two strings using pointer.

a. Write a program which reads a stream of characters terminated by  $*$  and outputs the number of occurrences of the particular substring present in the stream.

Ex. Character Stream = **ab**cbdc**ab**cbdbbcbad**abbaab**\*

Output- (ab) = 4

## III. ARRAYS/STRINGS

### Problem Set:

1. The mains voltage supplied by a sub-station is measured at hourly intervals over a 72 hour time period. Write a program to find

(1) the mean voltage measured

- (2) the hours (numbered 1 to 72) at which the recorded voltage varies from the mean by more than 10%
- (3) any adjacent hours when the change from one reading to the next was greater than 15% of the mean value.
2. A certain instructor awards letter grades to student papers having numeric scores in following manner. The papers with the highest and lowest marks are found, thus determining the range. Paper with marks in the top 25% of the range are awarded an A, papers with marks in lowest 30% of the range get a C and the rest get B.
3. Write a program to form and print a histogram. Data for the program is an integer N followed by N numbers. This is preceded by another integer M followed by M pairs of numbers, the  $i^{\text{th}}$  pair being the lower and upper bounds of the  $i^{\text{th}}$  disjoint range of values. Your program should output the table showing for each range, the lower and upper bounds of that range and the number of N values falling within it. A warning message should be printed for any data value not in any of M ranges.
4. Write a program which reads a pair of positive integers P and N followed by N number  $X_1, X_2, \dots, X_N$ . After having read  $X_i$  ( $i \geq P$ ) the program should output the average of  $X_{i-P+1}, \dots, X_i$ , thus producing the P-point moving average of the data items.
5. Imagine that you are producing sex\* ages\* Marital Status table for a census. Read in data for a large number of persons giving their name, age and whether or not they are married. The program should output table showing numbers of people in each category.  
For example part of the “male” table might look like
- |            |     |      |       |       |            |
|------------|-----|------|-------|-------|------------|
| sex = male |     |      |       |       |            |
| age        | 0-5 | 6-10 | 11-15 | 16-20 | 21-25..... |
| single     | 10  | 5    | 7     | 10    | 5          |
| married    | 0   | 0    | 0     | 4     | 5          |
6. In a possible tax system, income earners might pay (for instance) nothing on their first \$4000 income, 15% on the next \$5000, 30% on the next \$6000 and 50% on the the remainder. Write a program which reads the income levels and percentages for such a four part system and then prints a table of tax payable on income from 0 to \$25000 in steps of \$250.
7. In Italy, banknotes are issued for 50000, 2000, 10000, 5000, 2000, 1000 and 500 lire, coins are available for 100,50,20,10 and 5 lire. Write a program which reads in any sum of money and prints out of a breakdown into the smallest possible number of notes and coins needed to make it up. Your program should print an error message if the sum is over 2000000 or not a multiple of 5.
8. A matrix is singular if and only if its determinant is 0. Write a function which determines whether a matrix is singular or not.
9. Given a string s, print the smallest possible lexicographical string that can be obtained by removing at most one character from the string.
10. Given a string s, find the longest palindromic substring in the string s

## IV. POINTERS

2. Let's call any (contiguous) subarray B (of A) a *mountain* if the following properties hold:
  - $B.length \geq 3$
  - There exists some  $0 < i < B.length$  such that  $B[0] < B[1] < \dots B[i-1] < B[i] > B[i+1] > \dots > B[B.length - 1]$

(Note that B could be any subarray of A, including the entire array A.)

Given an array A of integers, return the length of the longest *mountain*.

3. Find number of consonants and vowels in a given string using pointers

## V. STRUCTURES/ UNIONS

### Problem Set:

1. Assume that there is a set of data consisting of records representing people. For each person, there is a name (20 characters), sex (M or F) and age (an integer in the range 0 to 100). Write a program which processes these records and outputs the number of men and the number of women.
2. Records for a set of employees include name, address, age, etc. but also information about whether they receive a weekly or monthly salary; the amount received per week or monthly salary; the amount received per week or per month is also present. Write a program which processes a set of these records and outputs
  - a. The amount of the weekly wage bill
  - b. The amount of the monthly wage bill excluding wages paid under (a) above
  - c. The total yearly wage bill.
  - d. The number of employees being paid by each means
3. A league table consists of a set of N records each representing the performance of a team. A record contains team name, no. of games played, no. of games won, no. of games drawn, no. of games lost, no. of goals scored, no. of goals conceded and no. of points awarded (2 for a win and 1 for a draw).
4. Write a program which inputs a positive integer N, N records of the form above, a positive integer M, the results of M games in the form  
team1 goals scored team2 goals scored.  
Based on the results of these M games, the program should update the records and display the updated records.
5. A record in an organisation's payroll consists of one line for each employee consisting of:  
NAME (20 characters), SEX (1 character M or F), SALARY (integer), DATE OF BIRTH (3 integers YEAR MONTH DAY).  
Write a program which will input 10 such records. Your program must then take in 5 amendments in the record set which will be in the same form as the record structure itself. The amendments can contain new employees to be added (name different from existing ones), employees left (salary given as 0) and update of salary (more or less). Your program must then incorporate these amendments and also remove those employees who have reached retirement age (Age 60).
6. Write a program which creates a structure representing a French/ English and an English/ French dictionary. There should be no duplication of words and efficient translation should be possible both ways. Your program must then return a French word corresponding to the given

English word if it is found in the dictionary otherwise, must output a suitable message.

7. A university keeps computerized records of all its students. These differ in certain crucial ways depending on the nature of a student's course of study; however certain basic information such as name, date of birth, etc. must be held for everyone. If a student is an undergraduate then his department, year of study, his passes to date will be held. For diploma students, there will be information about former qualifications and about course of study. For M. Tech. and Ph. D. students there will be information about his department, his thesis topic and supervisor. Write a program which inputs 5 students under each category. The program must then fetch the details of all Ph. D. students under computer science department and all those undergraduate students who have more than 6 passes to date across all departments.

## VI. FILES

### Problem Set:

1. A file EXAMMARKS contains a number of 80-character records each of which should have the following format:

Column(s) Content

1-20 Last name followed by initial

21 Blank

22-57 Nine 3-character fields each followed by a blank column. A 3-character field may be blank or may contain a right-justified unsigned integer. If present, the integer in the first field should be less than 41, any integers in subsequent fields should be less than 21.

58-80 blank

Write a program which reads EXAMMARKS and examines each record to see whether or not columns 21 to 57 are valid. Valid records should be output to file VALIDATED. Invalid records should be output to file INVALID. Invalid records should be output to file INVALID and each followed by one or more appropriate fault messages.

2. A college maintains an alphabetically ordered file of its staff. At the beginning of each academic year, an updated file is produced by a program which reads the old file and an amendments file containing the names of staff together with a code N indicating new staff or D indicating departing staff. Write a suitable program and test it. State clearly the limitations and assumptions of your programs.
3. Write a program to produce monthly statements for the customers of a bank. Assume that a file ordered by account number exists in which is held the balances in the accounts at the end of the previous statement period. A second file contains details of payments to and withdrawals from accounts during the current statement period.  
The program should output a statement for each customer. The statement should be headed by the account no. and list the balance brought forward, the transactions and the balance carried forward. For each day on which there was a transaction the statement should list the amount in the account at the end of the day.
4. Write a program to process a simple company payroll. An employee file ordered by employee number contains for each employee: name, rate of pay per hour and normal work week (in hours). The program is to read this file and one similarly ordered containing the no. of hours worked by each employee in the current week; assume that

employees are paid overtime at twice the normal rates. Arrange that the program, using simple tables, computes the income tax applicable and outputs a statement for each employee showing gross pay, net pay and tax withheld.