

- 1 A software developing company needs software to calculate how much each employee should be paid.

(a) A bonus payment may be added to an employee's salary. A pension payment may also be subtracted from an employee's salary.

The company needs to assess what additions and subtractions should be made to the salary of each employee. There are three conditions to check:

- If the employee has worked on a public holiday, they receive a 3% bonus payment.
- If the employee has worked 160 or more hours in a month, they receive an additional 5% bonus payment.
- If the employee pays into a pension, the company subtracts 4% for the pension payment.

Copy and complete the decision table to show the additions and subtractions. [3]

		Rules							
Conditions	Public holiday	Y	Y	Y	Y	N	N	N	N
	Hours $\geq$ 160	Y	Y	N	N	Y	Y	N	N
	Pension	Y	N	Y	N	Y	N	Y	N
Actions	3% bonus payment								
	5% bonus payment								
	4% pension payment								

(b) Explain the changes in the decision table after removing redundancies. [1]

(c) The company has decided to implement a program for the software using object-oriented programming (OOP).

The following names will be used for the OOP design:

Employee: Each employee has a unique employeeID, name, address and date of birth (dob).

There are two types of employee:

salary (SalaryEmployee) and
apprenticeship (ApprenticeshipEmployee).

SalaryEmployee: Salaried employees are paid a fixed monthly payment (MonthlyPayment). The hours a salary employee works in a month (HoursThisMonth) are recorded to calculate bonus payments. Status of worked on public holiday and pension are recorded. They may receive bonus payments and make pension payments (given in **part(a)**).

ApprenticeshipEmployee: Apprenticeship employees are paid weekly (HoursThisWeek). They receive an hourly rate of pay. Apprenticeship employees do not receive bonus payments or make pension payments.

Draw a class diagram that shows the following for the situation described above. [10]

- the superclass
- any subclasses
- inheritance
- properties
- appropriate methods

(d) A SalaryEmployee is paid a fixed monthly payment.

- If the employee has worked on a public holiday, they receive a 3% bonus payment. This is calculated from their MonthlyPayment.
- If the employee has worked 160 or more hours in a month, they receive an additional 5% bonus payment, calculated from their MonthlyPayment.
- If the employee pays into a pension, 4% will be subtracted from their MonthlyPayment.

Monthly salary is the final payment the employee receives.

For example, Ming Teck is a SalaryEmployee. His fixed MonthlyPayment is \$1000. He has worked a public holiday. He has worked 163 hours this month. He pays into a pension.

- The public holiday bonus is \$30 (3% of \$1000)
- The hours worked bonus payment is \$50 (5% of \$1000)
- The pension payment is \$40 (4% of \$1000)

Ming Teck's monthly salary is calculated as $(\$1000 + \$30 + \$50) - \$40 = \$1040$

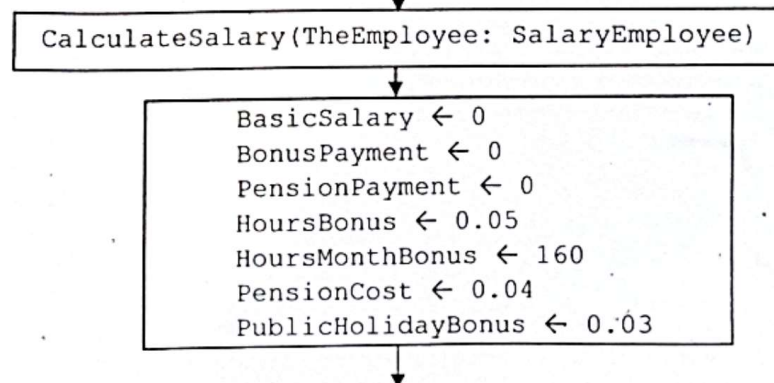
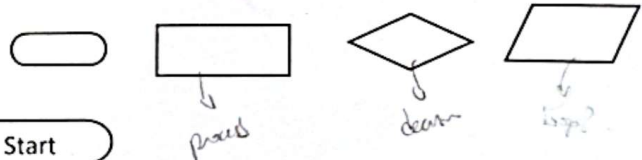
The function CalculateSalary() of SalaryEmployee is used to calculate the monthly salary.

It:

- takes a SalaryEmployee as a parameter
- using method(s) from within the class using . operator
- calculating the bonus payments and pension payment
- calculates and returns the monthly salary.

Copy and complete the flowchart below for the function CalculateSalary(). [6]

Symbols used for flowchart design:



Don't forget
to calculate
the pension

(e) (i) In OOP, state the purpose of polymorphism. [1]

(ii) What changes in design needs to be made if the objects of class `ApprenticeshipEmployee` also use `CalculateSalary()` to calculate the weekly salary. [1]

(f) Discuss the advantages of using modular design in software development. [2]

(g) The software design may need to change from time to time by a team of programmers. Explain how the team tracks the changes with a system. [2]

2 A company has a website. Users use the internet and the world wide web to access the website.

(a) Describe the difference between the internet and the world wide web. [1]

(b) Data packets are transmitted across a network from one computer to another computer. Describe the structure of a data packet. [1]

(c) Explain what is meant by the term router and describe the function of a router in a computer network. [2]

(d) Explain what is meant by circuit switching and packet switching in a computer network and give two advantages of packet switching over circuit switching. [4]

(e) A website of a company may collect information of the customers,

(i) State the meaning of privacy of data. [1]

(ii) State the meaning of integrity of data. [1]

(iii) Describe the following threats to a computer system. [4]

Spyware
Phishing email

3 Details of errors generated in a program are stored in a stack.

Details of each error are stored in the object of class structure namely `Error`.

(a) State which error will be the first retrieved from the stack. [1]

(b) The stack is implemented as a 1D array with the identifier `ErrorArray`.

The pointer `LastItem` stores the position of the last error in the array. Pointer will set to -1 initially.

(i) The function, `AddItemToStack`, takes the next error, the array, and pointer as parameters.

If the stack is full, the function returns `FALSE`; otherwise, it adds the error to the stack, changes the pointer's value and returns `TRUE`.

Copy and complete the following pseudocode for the function `AddItemToStack`. [4]

```

FUNCTION AddItemToStack(BYREF ErrorArray : ARRAY[0 : 99] OF Error,
                        BYREF LastItem : INTEGER,
                        BYVALUE Error1 : Error) RETURNS BOOLEAN

    IF LastItem = .....

        THEN

            RETURN .....

        ELSE
            ErrorArray[LastItem + 1] ← .....
            LastItem ← .....
            RETURN .....

        ENDIF
    ENDFUNCTION
  
```

(ii) Explain the reasons why `ErrorArray` and `LastItem` are passed by reference, but `Error1` is passed by value. [3]

(iii) The function `RemoveItem` takes the next error from the stack and returns it.

If there are no errors in the stack, it returns the global object `NullError`.

Copy and complete the pseudocode algorithm `RemoveItem`. [3]

```

FUNCTION RemoveItem(BYREF ErrorArray : ARRAY[0 : 99] OF Error,
                   BYREF LastItem : INTEGER) RETURNS Error

    DECLARE ItemToRemove : Error

    IF .....

        THEN
            RETURN .....
        ELSE
            ItemToRemove ← ErrorArray[.....]

            LastItem ← LastItem - 1

            RETURN .....
        ENDIF
    ENDFUNCTION
  
```

(iv) The errors that have been processed are stored in a global queue, `ErrorComplete`.

The function `Enqueue` adds an error to `ErrorComplete`:

`Enqueue (ErrorToAdd)`

- `Enqueue ()` returns `TRUE` if the error is successfully added to the queue and returns `FALSE` if the queue is full.

The procedure `RunError ()` should:

- remove an error from the stack using the function `RemoveItem ()`
- output message "Stack empty" if there are no errors in the stack
- if an error is returned, add the error to the queue using the function `Enqueue ()`
- if the error is added to the queue, output the message "Item added to queue"
- if the error is not added to the queue, output the message "Item not added to queue".

Copy and complete the pseudocode procedure `RunError ()`. [5]

```

PROCEDURE RunError(BYREF ErrorComplete : ARRAY[0 : 99] OF Error,
                  BYREF ErrorArray : ARRAY[0 : 99] OF Error,
                  BYREF LastItem : INTEGER)

    :::

ENDPROCEDURE
  
```

- (c) The stack can be implemented as a linked list with 2D arrays `ErrorArray` with eight (8) nodes.
The first column stores Error objects, the second column stores pointer to next object. Pointers should initialize to -1.

Identifiers `ErrorListHead`, `FreeSpaceListHead` are used as the linked list head and free space list head respectively.

- (i) Copy the following diagram and complete the linked list with `ErrorListHead` and `FreeSpaceListHead` and other relevant variables. The first five nodes were inserted with the following errors:

304-XX, 208-XY, 301-AB, 411-PX, 709-ZA [5]

ErrorArray	
index	
1	
2	
3	
4	
5	
6	
7	
8	

- (ii) Show the changes with another diagram of the linked list after an error removed from the stack. [4]

- (iii) Explain what the free space list is? [2]

- 4 Name and explain three different types of errors that could occur in a computer program. Given an example of each type of error with Python programming language. [3]

- 5 Merge Sort and Insertion Sort are two distinct sorting algorithms with different performance characteristics, particularly evident when analyzed using Big-O notation.

With selected dataset sizes (2^9 , 2^{10} , 2^{11} , 2^{13} , 2^{14} , 2^{15}) comparing these two sorts in terms of worst-case time complexity for large datasets. [6]

- 6 A computer uses the ASCII character set.

- (a) State with reason the number of characters that can be represented by the ASCII character set. [2]

- (b) Unicode is a different character set.

The Unicode value for the character '1' is denary value 49.

- (i) Write the hexadecimal value for the Unicode character '1'. Show your working. [1]

- (ii) Write the denary value for the Unicode character '5'. Show your working. [1]

7. A university wishes to store its data using a relational database.

The university records the following data for each student:

- student identification number
- name
- email

The university records the following data for each lecturer:

- lecturer reference number
- name
- department
- email

The university records the following data for each course it is offering:

- course reference code
- course name
- department
- number of credits

Students enrol in up to 5 courses in each semester which is taught by different lecturers.

The university records the following details for each enrolment:

- the course
- the student taking the course
- the lecturer teaching the course
- the student's score achieved in the course
- the semester

(a) Draw an entity-relationship (ER) diagram to show the tables in third normal form (3NF) and the relationship(s) between them. [3]

(b) Write table definitions, indicating the primary key with underline and foreign key with *, for each of the tables you identified in (a). [4]
Use the format: TableName (Attribute1, Attribute2, Attribute3*, etc.)

(c) Three lecturers teach the course CS202 in Semester 2025Sem1. After moderation, they decided to add 5 marks to all the students taking the course that semester. Write an SQL query to update the scores. [3]

(d) A student requires at least 100 accumulated credits to graduate. At the end of each semester, the university will generate a report to calculate the total number of credits each student has completed (you can assume that all students pass all of their courses).

Write an SQL query that will output all the students who have completed at least 100 credits. [4]

(e) State the two aims of normalisation. [2]

(f) The university is considering whether to move its data to a NoSQL database. [2]

(i) State two key differences between the two types of databases. [2]

(ii) State and explain which database system the university should choose. [2]

End of Paper