Q1 (a) Define the asymptotic notations $O$, $\Omega$, and $\Theta$. Briefly explain them using suitable diagrams. Also, define $o$ and $\omega$ notations. 6

OR

(a') Use a recursion tree to give an asymptotically tight solution to the recurrence $T(n) = T(\alpha n) + T((1-\alpha)n) + cn$, where $\alpha$ is a constant in the range $0 < \alpha < 1$ and $c > 0$ is also a constant.

(b) Show that the solution to the recurrence $T(n) = 2T\left(\left\lfloor \sqrt{n} \right\rfloor \right) + \log n$ is $O(\log n \log \log n)$. 6

Q2 (a) Prove that the lower bound on the complexity of sorting algorithm which is based on comparisons is $\Omega(n \log n)$. 5

OR

(a') Suppose that the splits at every level of Quick Sort are in the proportion $1 - \alpha$ to $\alpha$, where $0 < \alpha < \frac{1}{2}$ is a constant. Show that the minimum depth of a leaf in a recursion tree is approximately $\frac{\log n}{\log(1-\alpha)}$ and the maximum depth is approximately $\frac{\log n}{\log(1-\alpha)}$. Could... 2
(b) Show that
\[ \sum_{k=1}^{n^2} k \log k \leq \frac{1}{2} n^3 \log n - \frac{1}{8} n^3. \]

Using the above bound, show that the expected running time of RANDOMIZED-QUICKSORT that uses RANDOMIZED-PARTITION is \( O(n \log n). \)

Q3 (a) Briefly compare dynamic programming with divide-and-conquer method. Where is dynamic programming applied? What are the steps in developing a dynamic programming algorithm?

(b) Let there be four matrices with the following dimensions:

<table>
<thead>
<tr>
<th>Matrix</th>
<th>Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>( A_1 )</td>
<td>50x40</td>
</tr>
<tr>
<td>( A_2 )</td>
<td>40x60</td>
</tr>
<tr>
<td>( A_3 )</td>
<td>60x20</td>
</tr>
<tr>
<td>( A_4 )</td>
<td>20x70</td>
</tr>
</tbody>
</table>

Using a dynamic programming algorithm, determine the order of multiplying the chain of matrices \( A_1 A_2 A_3 A_4 \), so that the total number of scalar multiplications are minimized. Write all intermediate steps.

OR

(b') A strand of Deoxyribo-Nucleic Acid (DNA) consists of a string of molecules called bases, where the possible bases are adenine, guanine, cytosine, and thymine. Representing each of these bases by its initial letter, one can express a strand of DNA as a string over the finite set \{A, C, G, T\}. In some cases, it is required to determine the similarity between strands of two organisms. One way of measuring the similarity between two strands \( S_1 \) and \( S_2 \) is by finding a third strand \( S_3 \) in which the bases in \( S_1 \) appear in each of \( S_1 \) and \( S_2 \); these bases must appear in the same order, but not necessarily consecutively. The longer the strand \( S_3 \) one can find, the more similar \( S_1 \) and \( S_2 \) are. Briefly describe a dynamic programming algorithm for finding the longest common strand \( S_3 \). Let \( S_1 \) and \( S_2 \) be as follows:

\[ S_1 = ACGC \]
\[ S_2 = CTGAC. \]

Use the algorithm to find the longest common strand of \( S_1 \) and \( S_2 \).
Q 4 (a) Starting from the vertex \( a \), find a minimum spanning tree using Prim's algorithm for a graph given in Figure 1. Show all intermediate steps. What is the running time of Prim's algorithm for a graph \( G=(V,E) \) in terms of the number of edges \(|E|\) and the number of vertices \(|V|\)?

![Figure 1: A graph for finding minimum spanning tree using Prim's algorithm (Q4 (a)).](image)

(b) Find shortest paths from a source vertex \( s \) to all other nodes in a directed graph shown in Figure 2 using Dijkstra's shortest path algorithm. For a directed graph \( G=(V,E) \) with \(|V|\) number of vertices and \(|E|\) number of edges, what is the running time of the algorithm?

![Figure 2: A directed graph for Dijkstra's shortest path algorithm (Q4 (b)).](image)
(b') Find the maximum flow from the source $s$ to the sink $t$ in a flow network, which is shown in Figure 3, using the Ford-Fulkerson max-flow algorithm. For a graph $G=(V,E)$ with $|V|$ number of vertices and $|E|$ number of edges, what is the running time of the algorithm?

![Flow Network]

Figure 3: A flow network for finding the max-flow between $s$ and $t$ using Ford-Fulkerson algorithm (Q4 (b')).

Q5 (a) What is meant by $P$ and $NP$ classes of problems? When a problem is said to be an $NP$-complete problem?

(b) A vertex cover of an undirected graph $G=(V,E)$ is a subset $V' \subseteq V$ such that if $(u,v) \in E$, then $u \in V'$ or $v \in V'$ (or both). That is, each vertex "covers" its incident edges, and a vertex cover for $G$ is a set of vertices that covers all the edges in $E$. The size of a vertex cover is the number of vertices in it. The vertex cover problem is to find a vertex cover of minimum size in a given graph. Prove that the vertex cover problem is an $NP$-complete problem.

OR

(b') In the traveling salesman problem, a salesman wishes to make a tour visiting each city exactly once and finishing at the city he starts from. The salesman incurs a nonnegative integer cost $c(i,j)$ to travel from city $i$ to city $j$, and the salesman wishes to make the tour whose total cost is minimum, where the total cost is the sum of individual costs along the edges of the tour. Prove that the traveling salesman problem is an $NP$-complete problem.
1.(a) Give the following:
   - Unambiguous grammar for arithmetic expression
   - Syntax tree for the expression \( x-a*b+c*d \)
   - Regular definition for numeric constant

(b) Differentiate between token and lexeme. Identify tokens and lexemes in the following C language statement:
   `printf("Sum=%d\n", sum-30);`

2.(a) Give a grammar for arithmetic expression. Eliminate left recursion if there is any.
Construct predictive parsing table for your grammar.

(b) Construct SLR parsing table for the following grammar:
   \[ S \rightarrow (S) \mid S \mid \epsilon \]

OR

2'.(a) Consider productions \( A \rightarrow \alpha \) and \( A \rightarrow \beta \). Describe the conditions when these two productions will get added at the same location in the predictive parsing table.

(b) Consider operators \( \theta_1, \theta_2, \theta_3, \theta_4 \) and \( \theta_5 \) which are binary, infix and left associative operators. Further, \( \theta_1 \) has higher precedence than \( \theta_5 \). Following grammar which is ambiguous realizes expression consisting of these operators:
   \[ E \rightarrow E \theta_1 E \mid E \theta_2 E \mid E \theta_3 E \mid E \theta_4 E \mid E \theta_5 E \mid \text{id} \]
   SLR parsing table of above grammar has conflict. Describe as to how would you eliminate these conflicts.

3.(a) Describe the content of activation record block.

(b) Describe type expression of following using suitable example:
   - Function
   - Record

4.(a) List different forms of Three Address Instructions.

(b) Give syntax directed translation scheme to translate arithmetic expression to syntax tree.
4'. (a) Give syntax directed translation scheme to translate \( \oplus \) operator of C language to three address code.

(b) Describe DAG representation (a variant of syntax tree) for intermediate code.

5. (a) Give the definition of followings
- Dominator relation
- GEN and KILL of a block in Reaching Definition Analysis

(b) Write short note on any ONE of followings
- Live Variable Analysis
- Available Expression Analysis
2012-2013
B.TECH AUTUMN (VII SEMESTER) EXAMINATION
(COMPUTER ENGINEERING)
DESIGN OF PROGRAMMING LANGUAGES
(CO-403)
Credits: 04

Maximum Marks: 60

Note: Answer all questions. Make appropriate assumptions, if required. Symbols and abbreviations have their usual meanings.

1(a) What are various language design criteria? Define them.
(b) What are the requirements of a successful language?
(c) Write the ancestors of the following programming languages:
   (i) Ada (ii) ALGOL 68 (iii) C# and (iv) Haskell
(d) Describe the language implementation methods. Which one is best and why?

OR

(d') Explain with an example the two language design criteria that are on direct conflict with each other? Also give reasons of the conflict.

2(a) Define the following terms:
   (i) Descriptor
   (ii) Abstract data type
   (iii) Binding time
   (iv) Control structure
   (v) Guarded command
   (vi) Reference type data type

OR

(a') What are the design issues of subprograms? What are the parameter passing methods? Explain each of them with an example.
(b) What are design issues with array types?
(c) What are expressions? Explain them with their types and examples.
(d) Differentiate between counter controlled loops and logically controlled loops.

3(a) How concurrency is achieved and controlled in programming language?
(b) Discuss the support for object oriented programming.
(c) Differentiate between dynamic method binding and polymorphism.
(d) Describe the facilities of exception handling in JAVA with examples.

OR

(d') Explain how data hiding is achieved in OOP with example from Smalltalk and C++.
4(a) What are the characteristics of the pure functional programming languages?

OR

(a') Differentiate between functional and imperative programming languages.
(b) What are the functional forms of the Scheme language? Explain each of them with an example.
(c) Write a short note on predicate calculus and lambda calculus.

OR

(c') Write a function to sum all elements of a list in Scheme language.
2012-2013
B.TECH AUTUMN SEMESTER EXAMINATION
COMPUTER ENGINEERING
EMBEDDED SYSTEMS (CO - 448)

Maximum Marks : 60
Credits: 04
Duration : Three Hours

Attempt all questions
Make relevant assumptions wherever required.

1. (a) Briefly describe major steps in embedded system design process. 4
   (b) Give the design model for embedded systems showing the interdependence of 4
       various design activities.
   (c) Provide requirement list for a case study of devising a means to collect charges in 4
       a large-scale car park.

2. (a) Using PIC instructions write an assembly language program to implement a 6
     software delay of 500 μs. The system clock frequency is 10 MHz.
     (b) The oscillator of a 16F84 runs at 4.194306 MHz. Using the interrupt on overflow 6
         to generate a regular series of interrupts, what frequencies can be achieved?

OR

2' (a) Determine what the following routine is doing. Compute the number of cycles 6
   and the time to execute the routine. Assume clock speed of 4MHz.
   
   abc   MOV LW  0xFF
        MOVWF  count ; 'count' is a memory location
        next    DRCFSZ  count
        GOTO  next
        BSF  PORTB, 7

   (b) Write SHARC assembly code to implement the following C code. 3x2
       for (i = 0; i < 20; i++)
       
       z[i] = a[i] * b[i];

   (ii) Write ARM assembly code to implement the following C statement.
       
       z = (a << 2) | (b & 15);

3. (a) PIC uses Harvard memory structure which makes it difficult to embed data into 6
      program. Write a PIC program to implement a typical look up table.

   (b) Describe how a pulse of precise duration (say 10 ms) can be output using a 6
       programmable timer of a micro-controller? Assume that free running counter is 6
       incremented every 2 μs. Showing suitable diagram of the programmable timer 6
       output mechanism, write the sequence of events (or algorithm) for:
       (a) Generation of leading edge of pulse.
       (b) Termination of pulse i.e. time delay and generation of falling edge of the 6
           pulse.

Is it necessary to disable the interrupt during execution of part (a) or (b) ?

OR
Consider a real-time system which has four sources of interrupt, all of which can be active at the same time. The sources are identified by numbers 1, 2, 3, and 4, with 1 representing the highest priority source and 4 the lowest.

The corresponding interrupt service routine take \( T_1 = 31 \mu s, T_2 = 29 \mu s, T_3 = 37 \mu s, T_4 = 43 \mu s \), respectively.

The minimum time between interrupts from the same source is \( T_{p1} = 120 \mu s, T_{p2} = 200 \mu s, T_{p3} = 150 \mu s \), and \( T_{p4} = 1000 \mu s \), respectively.

For reliable operation, each source must be serviced before its next interrupt occurs and that interrupts are left disabled during servicing of any interrupt.

(a) Write down the expressions for interrupt interval and interrupt density constraints.

(b) Assume at the moment interrupt from source 4 is getting service from CPU, show graphically the latency for 3, if interrupt arrives in the order 3, 1, 2.

(c) Will operation of the above system be reliable? Find out, using the interrupt density constraint and interrupt interval constraint.

(d) If the mainline routine is to be permitted to include critical regions, during which interrupts are temporarily turned off, then how long can these last and still maintain reliable operation?

4

(a) If we want an average memory access time of 6.5 ns, our cache access time is 5 ns, and our main memory access time is 80 ns, what cache hit rate must we achieve.

(b) Answer the following questions about the ARM processor.

* How many general purpose registers are there?
* ARM uses register-indirect addressing. How do we get an address into a register?

(c) What is the purpose of the CPSR?

(d) Discuss methods used to reduce CPU power consumption in embedded applications.

5

Write short notes on any two of the following.

(i) Inter Integrated Circuit (I²C) Bus.
(ii) Memory technologies used in implementing EPROM, EEROM and Flash Memory.
(iii) Distributed embedded systems.
2012-2013
B.TECH AUTUMN (VII SEMESTER) EXAMINATION
(COMPUTER ENGINEERING)
MOBILE COMPUTING
CO-452
Credits: 04

Maximum Marks: 50

Duration: Three Hours

- Attempt all questions. All questions carry equal marks.
- Attempt two parts from a question.

1. a) Differentiate between 1G, 2G and 3G cellular networks. What are the main distinguishing features among them? Draw the diagram for CDMA forward transmission and explain in detail.

   b) In a tabular format list the various characteristics of cellular and cordless low-tier PCS technologies. What is the operating frequency for cellular networks and cordless networks? (OR)

   b) Write a detailed note on PCS architecture. Explain with the help of suitable diagrams.

2. a) What is handoff? Differentiate between soft-handoff and hard-handoff. Also, what is the difference between horizontal-handoff and vertical-handoff? Explain with the help of examples.

   b) What is the difference between inter-BS Handoff and Intersystem Handoff? Support your answer with suitable diagrams.

   b) How does roaming function in a mobile cellular network? What is roaming management? What do the terms HLR and VLR stand for?

3. a) What is cellular internet access? What do you understand by SGSN and GGSN? Explain in detail with the help of suitable diagrams.

   b) Explain in detail the SMS network architecture. (OR)

   b) Explain mobile number portability (MNP) in detail.
4. a) Differentiate between 3G and 4G technologies. Compare the different mobile internet access methods.

b) Explain the circuit switched fallback mechanism (CSFB).