Section A: Compulsory Questions (60marks)
(Answer ALL Questions in this Section)

Question 1

What is a TTPN? Give an example TTPN, and explain its features and annotations.

[6]

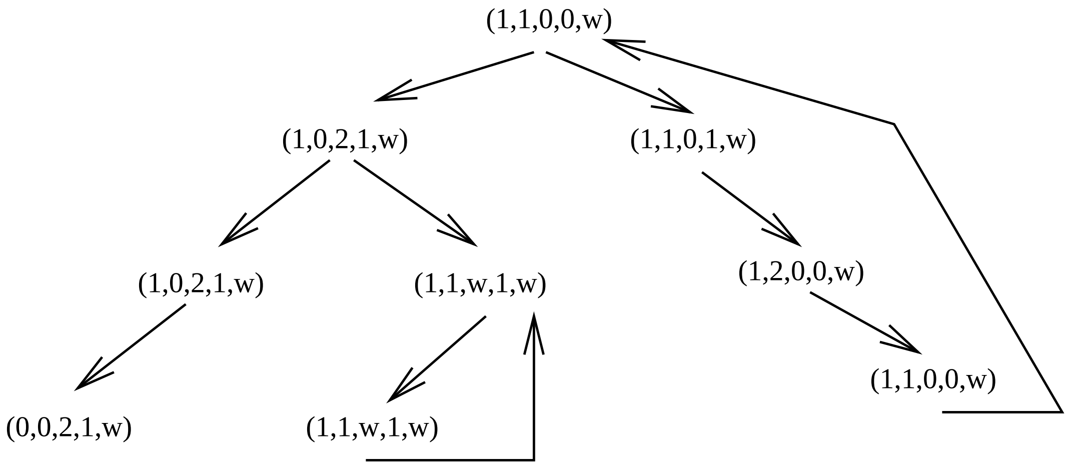
Question 2

Construct a TTPN model which represents the flow of traffic on a freeway at one of its entry feeds. Assume that the traffic from the feed lane merges into the continuous flow of traffic on the major road and that traffic flow analysis indicates that openings in the traffic are exponentially distributed. You may assume that traffic flow conditions are stable 24hrs per day.

[10]

Question 3

Given the following reachability tree; can the system with this tree achieve deadlock?



[4]

Question 4

List the problems inherent in multi-stage interconnection networks that are partially solved by introducing combining?

[3]

Question 5

Why is the following code poorly written?

What is the name of the problem demonstrated by this code?

What feature of the scheduling of data operations in parallel programming environments allows this problem to occur?

```
cobegin
    x:= x + 1;
■
    x:= x + 1;
coend
```

[6]

Question 6

State two common measures of network desirability mentioned in the the lectures. Provide formulae for these measures for arbitary size torus networks and a MIN with an arbitary number of inputs and outputs. An example MIN is the Omega network shown in the lectures.

[9]

Question 7

Do SIMD machines use control or data parallelism?

[2]

Question 8

Does MIMD programming provide fine or coarse grain parallelism? Justify your answer.

[6]

Question 9

What does a taxonomy of computer architectures aim to achieve?

[2]

Upon what basis does Flynn form the separation of parallel computer systems in his taxonomy.

[4]

Question 10

Recall that data operations on the DAP can move data on the machine's processor array. Given an 8x8 DAP and the following declarations and initialisations, state the value stored by each of the following statements.

[6]

```
REAL V1(), V2(), V3();

V1= (1, 3, 4, 5, 2, 3, 6, 9)

V2= SHLP(V1,3) + V1()
V3= SHRC(V2, 2) - V1(-)
```

Question 11

Define speedup, and maximum achievable speedup. Use diagrams if necessary.

[2]

Section B: Topic Questions (120 marks)
(Answer TWO questions from this section)

Question 12

A commercial transportation company maintains a fleet of trucks with which to transport customer packages between three major production centres (we will call the production centres A, B and C). Trucks leave A on a regular schedule 7 time units apart, but their destination is exponentially distributed between B and C. Trucks leaving B for A and C leave intermittently, and their frequency of departure is described by a function τ_f. These trucks are allocated to alternating destinations by a dispatcher. Trucks leave C for other destinations every 2 time units and proceed to destinations A and B in a ratio 1:2. That is, two trucks depart for B for every truck that departs for A. Assume the following initial configuration of trucks.

$$A = 40, B = 20, C = 90$$

Explain (in a couple of paragraphs) which of TTPN, PTPN or standard petri nets is best suited to modelling this system. Justify your answer.

[6]

Draw and annotate an appropriate petri net model of the system outlined above.

[24]

Question 13

What defines an inherently sequential algorithm?

[2]

Give a code example that illustrates the nature of inherently sequential code.

[4]

Say why your code example is inherently sequential.

[4]

Use the number of data transactions on the bus and the concept of data transformations to define an optimal sequential program.

[4]

Use the concept of data partitioning and synchronisation to define the notion of an optimal parallel program.

[4]

Write a simple k-parallel procedure in Modula-P which sorts an input array and writes the sorted results into an output array. Assume that the procedure is to be executed on a machine with up to 20 processing elements, and that 256K unique integer values are to be sorted. Your procedure must work when called for degrees of parallelism from 1 (sequential) to 20 (most parallel).

[12]

Question 14

What are the hardware options for implementing data flow programs? List three different alternatives and discuss how each of them deals with recursion. Is recursion possible for all the alternatives that you have described?

[6]

What is the most important restriction that must be applied to imperative languages to allow them to generate a data flow graph. Think of SISAL when framing your answer.

[2]

The restriction you have identified above presents difficulties when designing loop commands for data flow languages. What language feature does SISAL introduce to address these difficulties?

[4]

Draw a data flow graph that demonstrates the parallelism inherent in the following computations.

$$x = a * b + c * d - f$$
$$q = a + b/(c * d)$$
$$y = q + a/f$$

[9]

Assume that all these operations take 1 clock cycle to execute, and that data transmission is instantaneous. How many clock cycles are required to complete all these computations?

[2]

What is the principal bottleneck in the Manchester data flow computer architecture?

[2]

Name the three types of dataflow nodes which must be introduced to handle loops. Draw a picture of each node type, labelling its inputs and outputs and indicating their data types (Eg. boolean or normal data)

[5]