LSP Exam 2019 – Questions and Answers [Official Answers Included]

> **CVUT FEL (ČVUT) – České vysoké učení technické v Praze | Czech Technical University in Prague**
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>   **This file contains official answers (Official Answers Included)**

Question 2: RS Latch Circuit Simulation Frequently Tested

Question: Given inputs A, B, C values at times t0, t1, t2, t3 as shown, write the Q output value.

```
A = ..0..|..1..|..1..|..1..|
B = ..0..|..0..|..0..|..1..|
C = ..1..|..1..|..0..|..0..|

t0   t1   t2   t3
```

Answer
```
Q = ...1...|…0….|…0….|…1.…|
```

Question 3: Shannon Expansion Frequently Tested

Question: Decompose the function `Q=f(A,B,C,Q)` into:
```
Q = (not Q and f0(A,B,C)) or (Q and f1(A,B,C))
```

Solution Method

Step 1: Let Q=0, find f0
```
f0 := f(A,B,C,'0')
   := (A   B) · ('0' + (B   C))
   := (A   B) · (B   C)
```

Step 2: Let Q=1, find f1
```
f1 := f(A,B,C,'1')
   := (A   B) · ('1' + (B   C))
   := (A   B) · '1'
   := (A   B)
```

Karnaugh Map for f0: (A   B) · (B   C)

```
      C=0   C=1
AB=00  0    1
AB=01  0    0
AB=11  1    0
AB=10  0    0
```

Circle: (ABC) + (ABC) = (A   B)(B   C)

Karnaugh Map for f1: (A   B)

```
      C=0   C=1
AB=00  1    1
AB=01  0    0
AB=11  1    1
AB=10  0    0
```

Circle: (AB) + (AB) = (A   B) = A XNOR B

Question 5: Equivalent Logic Functions Frequently Tested

Question: Mark all logic functions that are equivalent to other functions:

```vhdl
f1 <= (A xor C) or (A and not C);
f2 <= (B or C) and (not A or B or C);
f3 <= ((C and not B) or (B and A));
f4 <= (A or C) and (not A or not C);
f5 <= (A and not B) xor (A and C);
f6 <= (A and not C) or (C and not A);
```

Answer

Analyze each function using Karnaugh maps:

Karnaugh Map for f4:
```
(A or C) and (not A or not C)
= (A + C) · (A + C)
= A·A + A·C + C·A + C·C
= A·C + A·C
= A   C
```

Karnaugh Map for f6:
```
(A and not C) or (C and not A)
```

```
= A·C + C·A
= A   C
```

Conclusion: **f4   f6** (both are A XOR C)

Truth Table Quick Reference

A   C (XOR) Truth Table

A	C	A C
0	0	0
0	1	1
1	0	1
1	1	0

A   B (XNOR) Truth Table

A	B	A B
0	0	1
0	1	0
1	0	0
1	1	1

Knowledge Summary

Shannon Expansion Solution Steps

1. **Identify feedback variable**: Find the variable that is both input and output (e.g., Q)
2. **Substitute Q=0**: Get f0(other variables)
3. **Substitute Q=1**: Get f1(other variables)
4. **Draw Karnaugh maps**: Draw maps for f0 and f1 separately
5. **Verify**: Q = Q·f0 + Q·f1

Equivalent Function Identification Tips

1. First simplify each expression
2. Compare using Karnaugh maps
3. Note XOR and XNOR equivalent forms:
   - A   C = A·C + A·C
   - A   C = A·C + A·C = (A   C)