

## CPE 64 PAL Worksheets – Combinational Logic, Adders, Multipliers and Multiplexers

A combinational circuit consists of an inter connection of logic gates, whose outputs are determined from present combination of inputs only. In a combinational circuit there will be 'n' input binary variables which come from external sources and there will be 'm' output variables which are produced by the internal combinational logic circuit.

- 1) For 'n' input variables how many possible combinations of binary inputs will the system have?
- 2) Is it true that for each possible input combination there is only one possible output combination?
- 3) For the combinational circuit with 'm' output variables the combinational circuit can be described by how many Boolean functions?
- 4) If a circuit is given, how do we make sure it is a pure combinational circuit and not a sequential circuit?
- 5) For 'n' inputs in the truth table the binary numbers will be listed from 0 to \_\_\_\_\_?

A multiplexer is a combinational circuit that selects binary information from one of the many input lines and directs it to a single output line. The selection of a particular input line is controlled by a set of selection lines.

- 6) If there are  $2^n$  input lines how many selection lines should be there to determine the output.
- 7) Derive the sum and carry-out expressions of 1-bit full adder and implement this full adder using Half adders.
- 8) Can two 4-bit adders be cascaded to construct an 8-bit adder? And what is the disadvantage of doing such a design?

Multiplication of binary numbers is performed in the same way as multiplication of decimal numbers. The multiplicand is multiplied by each bit of the multiplier, starting from the least significant bit. Each such multiplication forms a partial product. Successive partial products are shifted one position to the left. The final product is obtained from the sum of the partial products.

- 9) Can you build a multiplier circuit that multiplies two 2-bit binary numbers A and B. In other words,  $A = A_1 A_0$  (2 bits) and  $B = B_1 B_0$  (2 bits). You can build an Array multiplier circuit. Use Half Adders, Full Adders, And gates or any other combinational logic circuit you learnt so far.
- 10) How can you modify the Array multiplier circuit to multiply two 4-bit numbers?