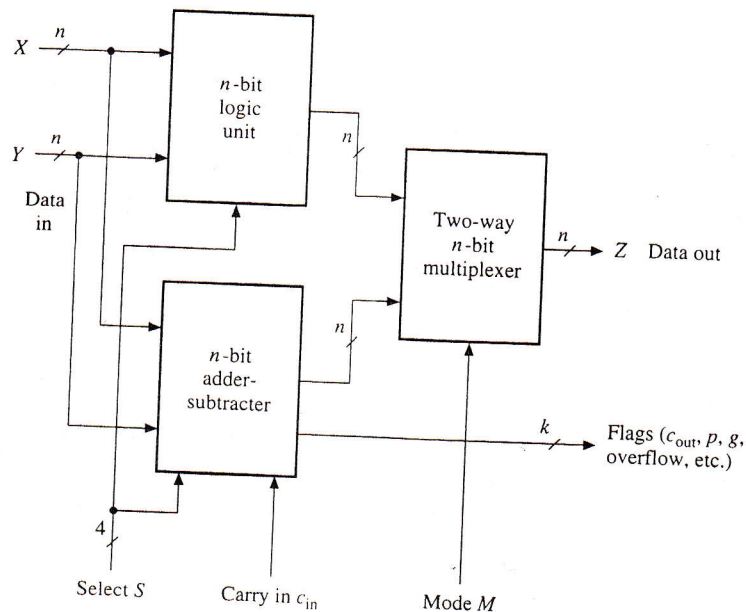


## 4.2 ARITHMETIC-LOGIC UNITS

The various circuits used to execute data-processing instructions are usually combined in a single circuit called an arithmetic-logic unit or ALU. The complexity of an ALU is determined by the way in which its arithmetic instructions are realized. Simple ALUs that perform fixed-point addition and subtraction, as well as word-based logical operations, can be realized by combinational circuits. ALUs that also perform multiplication and division can be constructed around the circuits developed for these operations in the preceding section. Much more extensive data processing and control logic is necessary to implement floating-point arithmetic hardware, as we will see later. Some processors having fixed-point ALUs employ special-purpose auxiliary units called arithmetic (co)processors to perform floating-point and other complex numerical functions.

### 4.2.1 Combinational ALUs

The simplest ALUs combine the functions of a two's-complement adder-subtractor with those of a circuit that generates word-based logic functions of the form  $ALU$  for example, AND, XOR, and NOT. They can thus implement most of a CPU's fixed-point data-processing instructions. Figure 4.28 outlines an ALU that has separate subunits for logical and arithmetic operations. The particular class of operation (logical and arithmetic) to be performed is determined by a "mode" control line  $M$  attached to a two-way multiplexer that channels the required result to the



**Figure 4.28**  
A basic  $n$ -bit arithmetic-logic unit (ALU).