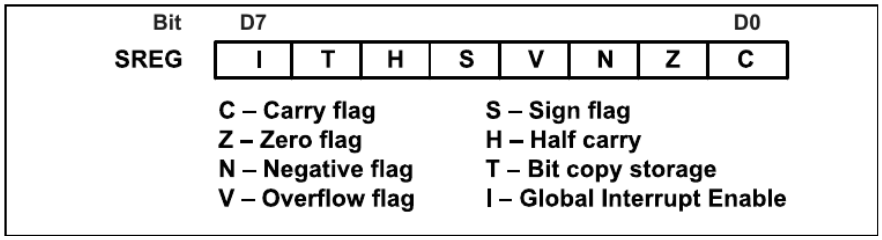
ATMEGA32 - STATUS REGISTER

- It is an 8 bit register called SREG register. Also called Flag register. It has the following format.



- The flag bits C, Z, N, V, S, and H are called conditional flags. Conditional flags can be used to perform a conditional branch (jump).
- **Carry flag, C** : This flag is set whenever there is a carry out from the D7 bit.
- **Zero flag, Z** : If the result of an arithmetic or logic operation is zero, then Z = 1. Therefore, Z = 0 if the result is not zero.
- **Negative flag, N** : If the D7 bit of the result is zero, then N = 0 and the result is positive. If the D7 bit is one, then N = 1 and the result is negative
- **Overflow flag, V** : This flag is set whenever the result of a signed number operation is too large, causing the high-order bit to overflow into the sign bit. The V and N flag bits are used for signed number arithmetic operations.
- **Sign flag, S** : This flag is the result of Exclusive-ORing of N and V flags.
- **Half carry flag, H** : If there is a carry from D3 to D4 during an ADD or SUB operation, this bit is set; otherwise, it is cleared. Used to perform BCD arithmetic.
- **Bit copy storage, T** : (T- for temporary) : used to copy a bit of data from one GPR to another GPR.

  For example, the following program copies bit 3 from R17 to bit 5 in register R19:

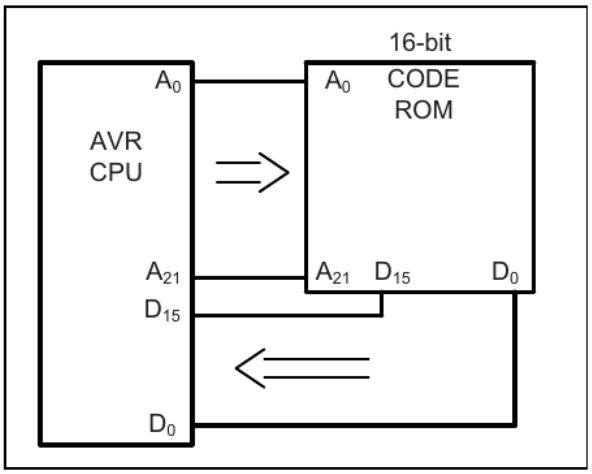
```
BST R17, 3    ;store bit 3 from R17 to the T flag
BLD R19, 5    ;copy the T flag to bit 5 in R19
```

- **Global interrupt Enable, I** : Global interrupt control

AVR PROGRAM COUNTER (PC) AND PROGRAM ROM SPACE

- The program counter (PC) is a register in CPU, which points to the address of the next instruction to be executed
- As the CPU fetches the opcode from the program ROM, the program counter is incremented automatically to point to the next instruction.
- Width of the PC determines the maximum size of the program ROM. For example, a 14-bit program counter can access a maximum of 16K (2^{14} = 16K) program memory locations.
- In AVR microcontrollers each Flash memory location is 2 bytes wide.
- For example, in ATmega32, whose Flash is 32K bytes, the Flash is organized as 16K × 16, and its program counter is 14 bits wide (2^{14} = 16K memory locations).
- The program counter in the AVR family can be up to 22 bits wide. So it supports a total of 4M locations, with each location size of 2 Bytes, giving 8M capacity.
- When the AVR microcontroller is powered up, the value of PC is zero. So the first opcode is to be stored at ROM address zero.
- From the code ROM, two bytes can be accessed at a time. Most of the instructions are 2-byte instructions and can be fetched in a single cycle.

Following figure shows the internal connection of code ROM with AVR CPU



ATMEGA32 – I/O PORTS

I/O ports are used to send outputs from or to get inputs to the microcontroller. The ATmega32 has four I/O ports, namely PORTA, PORTB, PORTC and PORTD. Each port has 8 pins, to send or receive bits. These port pins are multiplexed so that the programmer can use these pins for other uses also. Individual pins are represented like PA0 or PA.0, which means the pin 0 of portA.

Registers associated with I/O ports:

Each port has three registers associated with it, which is denoted as DDRx, PORTx and PINx. For example, portB has the registers – DDRB, PORTB and PINB. Similarly PortC has three registers – DDRC, PORTC and PINC.

- DDRx: It is the Data Direction Register. It is used to set the data direction (input/output) of the associated port. Setting DDRx bits to one indicate the corresponding port pin is output, and setting DDRx pins to zero indicate the corresponding port pin is input.

  For example :
  - DDRA=0xFF sets all the pins of portA as output.
  - DDRB=0x01 sets PB0 as output and all other pins of portB as input.

- PORTx: It is the port output register. To send data to a port, we have to assign that data to PORTx register. For example, to send the value 0x56 to portC, we write PORTC=0x56

- PINx : It is the port input register. The data bits arrived at port pins are available in this register. For example, the register PIND contains the data from portD pins.