

GATE Exercises on ATMEGA328P

Abstract—This problem set has questions taken from GATE papers over the last twenty years suitably modified for the ATMEGA328P microcontroller, present in the Arduino Uno. Teachers can use the problem set for course tutorials.

- 1) Calculate the execution time for the following assembly code given that the code will be running on an Atmega328p 8-bit micro-controller being clocked by a 16MHz oscillator.

Instructioncode	Cyclestoexecute
<i>LDIR16, 5</i>	1
<i>Again : DECR16</i>	1
<i>NOP</i>	1
<i>BRNEAgain</i>	2
<i>NOP</i>	1
<i>NOP</i>	1

- a) $5.5\mu s$
 b) $1.37\mu s$
 c) $2.5\mu s$
 d) $7.0\mu s$
- 2) After execution of RET instruction in an Atmega328P controller, the stack pointer is
- a) Decremented by 1
 b) Decremented by 2
 c) Incremented by 1
 d) Incremented by 1
- 3) The following instructions were executed on an Atmega328P controller.

```
ldi r16,0xFC
out DDRD,r16
ldi r17,0x03
out PortB,r17
Start:
ldi r18,0x33 ;33H
ldi r19,0x78 ;78H
ldi r20,0x32 ;32H
```

```
add r18,r19
COM r18
```

```
and r18,r20
mov r21,r18
lsl r21
lsl r21
mov r22,r18
```

```
ldi r23,0x06
LOOP: lsr r22
dec r23
brne LOOP
```

```
out PORTD,r21
out PORTB,r22
rjmp Start
```

The values of Register r21 and r22 immediately after the execution of the instructions (in Hex) are

- a) 0 and 0
 b) 1 and 0
 c) 1 and 1
 d) 3 and 2
- 4) In an Atmega328P Micro controller, which of the following instruction affects carry flag
- a) NEG
 b) EOR
 c) CBR
 d) SER
- 5) For Atmega328P Micro controller, following code executed

```
ldi r16,0xFC
out DDRD,r16
ldi r17,0x03
out PortB,r17
Start:
ldi r18,0x50 ;05H
ldi r19,0x50 ;05H
ldi r20,0x03 ;03H
```

```
Loop1:
add r18,r19
dec r19
```

```
brne Loop1
```

```
add r18,r20
  mov r21,r18
  lsl r21
  lsl r21
  mov r22,r18
```

```
      ldi r23,0x06
LOOP: lsr r22
      dec r23
      brne LOOP
```

```
out PORTD,r21
out PORTB,r22
rjmp Start
```

At the end of program,the values of r21 and r22 respectively

- a) 1 and 7
- b) 2 and 0
- c) 2 and 3
- d) 0 and 5

- 6) An Atmega328P assembly language program is given below. Assume that the carry flag is initially unset.The content of the register r24 and r18 respectively

```
ldi r16,0xFC
out DDRD,r16
ldi r17,0x03
out PortB,r17
```

```
Start:
ldi r18,0x07 ;07H
```

```
lsl r18
mov r19,r18
lsl r19
lsl r19
adc r18,r19
mov r24,r18
```

```
lsl r24
lsl r24
out PORTD,r24
```

```
      ldi r23,0x06
LOOP: lsr r18
      dec r23
      brne LOOP
```

```
out PORTB,r18
rjmp Start
```

- a) 8 and C
- b) 6 and 4
- c) 2 and 3
- d) 1 and 5

- 7) Which of the following interrupt has the highest priority in an Atmega328P controller

- a) RESET
- b) INT0
- c) INT1
- d) PCINT2

- 8) The number of clock cycles required to execute the following Atmega328P instructions.

I. LD R20, 0xX
II. LDI R22,0xF1H
would be

- a) 2 for I and 1 for II
- b) 4 for I and 3 for II
- c) 2 for I and 2 for II
- d) 1 for I and 1 for II

- 9) In an Atmega328P microcontroller, the instruction CP r16,r17 has been executed while the content of the r16 is less than that of register r17 . As a result?

- a) Carry flag will be set but Zero flag will be reset
- b) Carry flag will be reset but Zero flag will be set
- c) Both Carry flag and Zero flag will be reset
- d) Both Carry flag and Zero flag will be set

- 10) The number of interrupts (which require an external signal to interrupt) present in an Atmega328P Micro controller are

- a) 26
- b) 20
- c) 15
- d) 30

- 11) In the Atmega328P Micro controller, the INT0 instruction transfers the program execution to the following location

- a) 0x0002
- b) 0x0000
- c) 0x0004
- d) 0x0003

- 12) Find the correct match among the following pair in the context of an Atmega328P Micro controller :

(a)ADC	(e)Programcontrolinstruction
(b)LDI	(f)DatamovementInstruction
(c)INT0	(g)Interruptinstruction
(d)RJMP	(h)Arithmeticinstruction

- a) a-e, b-f, c-g, d-h
 b) a-h, b-g, c-f, d-e
 c) a-h, b-f, c-g, d-e
 d) a-f, b-h, c-g, d-e
- 13) The following is an assembly language program for an Atmega328P:

```
ldi r16,0xFC
out DDRD,r16
ldi r17,0x03
out PortB,r17
```

Start:

```
ldi r18,0x06 ;06H
ldi r19,0x70 ;70H
```

```
add r18,r19
```

```
ldi XL,0x00
ldi XH,0x01
ST X,r18
eor r18,r18
```

```
lsl r18
lsl r18
mov r22,r18
out PORTD,r18
```

```
ldi r23,0x06
LOOP: lsr r22
dec r23
brne LOOP
```

```
out PORTB,r22
```

After execution of program ,contents of register r21 and r22 respectively

- a) 0 and 0
 b) 7 and 0
 c) 0 and 6
 d) 7 and 6
- 14) The vectored address corresponding to the

interrupt command WDT(Watchdog Time-out Interrupt) in an Atmega328P Micro controller is

- a) 000BH
 b) 000CH
 c) 0700H
 d) 0027H

- 15) In an Atmega328 Microcontroller the DATA bus is

- a) 16
 b) 8
 c) 6
 d) 4

- 16) In an Atmega328P, CY flag may be set by the instruction

- a) SUB
 b) INC
 c) AND
 d) LDI

- 17) The subroutine SBX given below is executed by an Atmega328P Micro controller. The value in the register r18 immediately after the execution of the subroutine will be:

```
SBX:ldi r16,0x99
ldi r17,0x11
add r16,r17
mov r18,r16
RET
```

- a) 00H
 b) 11H
 c) 99H
 d) AAH

- 18) In an Atmega328P Micro controller,the main program calls the subroutine SUB1 given below. When the program returns to the main program after executing SUB1, the value in the register R16 is

```
SUB1:LDI R16,0x00
CALL SUB2
SUB2:INC R16
RET
```

- a) 00
 b) 01
 c) 03
 d) 04

- 19) The following is an assembly language program for Atmega328P Micro controller

```
ldi R16,0x06
ldi R17,0x70
add r16,r17
ldi xl,0x07
ldi xh,0x10
st x,r16
eor r16,r16
```

After the execution of the above program, the register r16 contains

- a) 00H
- b) 06H
- c) 70H
- d) 76H

- 20) An Atmega328P Microcontroller assembly language program is given as follows. The execution time of each instruction is given against the instruction in terms of T-state.

<i>Instruction</i>	<i>T – states</i>
<i>LDIR16,0x0A</i>	<i>7T</i>
<i>LOOP : LDIR17,0x05</i>	<i>7T</i>
<i>DECR17</i>	<i>4T</i>
<i>DECR16</i>	<i>4T</i>
<i>BRNES LOOP</i>	<i>10T/7T</i>

The execution time of the program in terms of T - states is

- a) 247 T
 - b) 254 T
 - c) 250 T
 - d) 257 T
- 21) A $2k \times 8$ bit RAM is interfaced to Atmega328 Microcontroller. If the address of the first memory location in the RAM is 0800H, the address of the last memory location will be
- a) 1000H
 - b) 0FFFH
 - c) 4800H
 - d) 47FFH
- 22) In an Atmega328 Microcontroller ,Half carry is useful in
- a) BCD Arithmetic
 - b) Excess 3
 - c) Two's complement
 - d) Data transfer
- 23) If the following program is executed in an Atmega328 Microcontroller, the number of instruction cycles it will take from START TO HALT is

```
START LDI R16, 0x14
SHIFT LSL
BRNE SHIFT
HALT
```

- a) 4
- b) 8
- c) 13
- d) 16

- 24) In an Atmega328 Microcontroller ,the following program executed

<i>Address</i>	<i>Instructioncode</i>
<i>2000H</i>	<i>eorr16,r16</i>
<i>2001H</i>	<i>ldir17,0x04</i>
<i>2003H</i>	<i>ldir18,0x03</i>
<i>2005H</i>	<i>rorr18</i>
<i>2006H</i>	<i>decr17</i>
<i>2007H</i>	<i>brne2005</i>
<i>200AH</i>	<i>hlt</i>

At the end of program ,register r18 contains

- a) 60H
 - b) 30H
 - c) 06H
 - d) 03H
- 25) In an Atmega328 Microcontroller, the contents of the register r16, after the following instructions are executed will become
- ```
eor r16,r16
ldi r17,0xF0
SUB r16,r17
```
- a) 01H
  - b) F0H
  - c) 10H
  - d) 0FH
- 26) The following program is written for an Atmega328 Microcontroller to add two bytes located at memory addresses 1FFE and 1FFF
- ```
LDI XL,0xFE
LDI XH,0x1F
LDI R16,X
INC XL
LDI R17,X
ADD R16,R17
INC XL
ST X,R16
```

EOR R16,R16

On completion of the execution of the program, the result of addition is found

- a) in the register A
- b) at the memory address 1000
- c) at the memory address 1F00
- d) at the memory address 2000

27) Consider the sequence of an Atmega328 instruction given below.

```
LDI ZL,58
LDI ZH,92
LPM R16,Z
COM R16
SPM Z,R16
```

Which one of the following is performed by this sequence?

- a) contents of location 9258 are moved to the register R16
- b) contents of location 9258 are compared with the contents of register R16
- c) contents of location 8529 are complemented and stored in location 8529
- d) contents of location 5892 are complemented and stored in location 5892

28) An 8Kx8 bit RAM is interfaced to an Atmega328 Microcontroller. In a fully decoded scheme, if the address of the last memory location of this RAM is 4FFFH, the address of the first memory location of the RAM will be

- a) 1000H
- b) 2000H
- c) 3000H
- d) 4000H

29) The following 8085 instructions are executed sequentially.

```
PROG: EOR R16,R16
      MOV R17,R16
      MOV R18,R17
      INC R18
      ADD R17,R17
      ADC R18,R18
```

After execution, the contents of R18 and R17 registers are

- a) 00 and 00
- b) 00 and 01
- c) 00 and 02

d) 01 and 01

30) Addressing mode used in an instruction of the form CLC

- a) Implicit Addressing
- b) Direct Program Addressing
- c) Data Indirect Addressing
- d) Register Direct

31) consider the following loop

```
MOV CX,0x8000
L1:DEC CX
   BRNE L1
```

The microcontroller is running at 14.7456/3 MHz and DEC CX require two clock cycles and BRNE requires 16 clock cycles .The total time taken is nearly

- a) 0.01s
- b) 0.12s
- c) 3.66s
- d) 4.19s

32) If the operating frequency of Atmega328p is 16MHz and ,if for the given instruction ,the machine cycle consist of 10 T states ,what will be the time taken by the machine cycle to complete execution of same instruction when three waits states are inserted ?

- a) 0.8 μ s
- b) 0.6 μ s
- c) 0.2 μ s
- d) 7 μ s

33) In an Atmega328 system containing 8KB of ROM and 8KB of RAM , the ROM is selected when A 15 is 0 and the RAM is selected when A15 is 1. A13 and A14 are unused. The CPU executes the following program

```
LDI R16,0x00
STS 0x8080,R16
DEC R16
STS 0xC080,R16
RET
```

34) The content of memory location 0x8080 after the execution of the RETURN instruction is

- a) FFH
- b) FEH
- c) 00H
- d) 01H

- 35) In an Atmega328p microcontroller, which one of the following is the correct sequence of the machine cycles for the execution of the DEC Z instruction?
- a) op-code fetch.
 - b) op-code fetch, memory read, memory write.
 - c) op-code fetch memory read.
 - d) op-code fetch memory write, memory write.