

Students must check the number of pages in this examination paper before beginning to write, and report any discrepancy immediately.

Total marks: 75

Time allowed: 2 hours

Section A (30 marks): For each question in this section, place an X beside all answers that apply. Each question is worth 6 marks. Partial marks are not given for incomplete answers.

Question 1: For a 7-bit two's complement number in AVR:

- ☐ The maximum positive value is 0b0111111
- ☐ The most negative value is 0b1000000
- ☐ Zero can be represented as 0b0000000 or 0b1000000
- ☐ The range of values is -64 to +63
- ☐ None of the above

Question 2: Regarding AVR memory addressing:

- ☐ The Z register can be used for indirect jumps
- ☐ The Y register consists of r29:r28
- ☐ Post-increment addressing updates the pointer after accessing memory
- ☐ ld and st instructions can only use X, Y, or Z registers
- ☐ None of the above

Question 3: In the context of AVR I/O ports:

- ☐ Writing 1 to a DDRD bit makes that pin an input
- ☐ Pull-up resistors are enabled by default
- ☐ The PORTD register can be read and written
- ☐ Pin states can be read regardless of direction setting
- ☐ None of the above

Question 4: The AVR status register:

- ☐ Is automatically saved during interrupt handling
- ☐ Contains the global interrupt enable bit
- ☐ Is modified by arithmetic and logic instructions
- ☐ Can be directly copied to a general-purpose register
- ☐ None of the above

Question 5: For AVR branch instructions:

- ☐ Branch targets must be within -64 to +63 words of the branch
- ☐ Multiple conditions can be tested in a single branch
- ☐ rjmp has a greater range than breq
- ☐ Branch instructions are two bytes long
- ☐ None of the above

Section B (25 marks): Short Answer Questions

Question 6 (5 marks):

Explain how the AVR hardware stack operates during an interrupt service routine, including register preservation and return address handling.

Question 7 (5 marks):

Describe the purpose of the AVR status register's H (half-carry) flag and when it becomes relevant in arithmetic operations.

Question 8 (5 marks):

Compare direct and indirect addressing modes in AVR assembly, explaining their advantages and typical use cases.

Question 9 (5 marks):

Explain how the AVR processor handles the overflow flag (V) in signed arithmetic operations. Provide specific examples.

Question 10 (5 marks):

Describe the function and importance of the linker command file in AVR program development.

Section C (20 marks): Assembly Programming Problems

Question 11 (4 marks):

Write AVR assembly code to swap the contents of two memory locations without using any general-purpose registers.

Question 12 (4 marks):

Write code to configure Timer1 for PWM operation on OC1A (Port B, pin 1) with a frequency of 50Hz.

Question 13 (4 marks):

Write an interrupt service routine for External Interrupt 0 that toggles all bits in PORTB while preserving all register values.

Question 14 (4 marks):

Write assembly code to perform a 16-bit addition of values stored in SRAM at addresses DATA1 and DATA2, storing the result at address RESULT.

Question 15 (4 marks):

Write code to rotate an 8-bit value in r16 right by the number of positions specified in r17, preserving the original value in r16.