Indian Institute of Technology Kharagpur End-Spring Semester Examination 2017-18

Date of Examination:<u>25 April 2018</u>Session:FNDuration:<u>3 Hours</u>Subject No.:<u>EE30004</u>Subject:<u>Embedded Systems</u>Department/Center/School:Electrical Engineering Credits:3 Full marks:100

Instructions

- 1. This question paper contains 4 pages and 7 questions. All questions are compulsory. Marks are indicated in parentheses. This question paper has been cross checked and no errors exist.
- 2. Detach the pages 3-4, fill the answers on them and attach with the answer script.
- 3. Please write your name, roll number, subject name and code, date and time of examination on the answer script before attempting any solution.
- 4. Use of electronic calculators only is permitted. No extra resources viz. graph papers, log-tables, trigonometric tables would be required.
- 5. **Organize your work**, in a reasonably neat and coherent way. Work scattered all over the page or across the answer script without a clear ordering will receive very little marks.
- 6. Mysterious or unsupported answers will not receive full marks. A correct answer, unsupported by calculations, explanation, or circuit diagrams will receive no marks; an incorrect answer supported by substantially correct calculations and explanations may receive partial marks.
- TM4C123 has the following data address range. \$0000.0000 \$0003.FFFF for FlashROM, \$2000.0000 - \$2000.7FFF for RAM, \$4000.0000 - \$400F.FFFF for external I/O ports and \$E000.0000 - \$E004.1FFF for internal I/O port buffer. On the other hand in TM4C1294 the data address range used is \$0000.0000 - \$000F.FFFF for FlashROM, \$2000.0000 -\$2003.FFFF for RAM, \$4000.0000 - \$400F.FFFF for external I/O ports and \$E000.0000 - \$E004.1FFF for internal I/O port buffer.
 - (a) (8 points) Calculate the size in bytes of the FlashROM, RAM, external I/O, internal I/O port buffer in TM4C123 and TM4C1294?
 - (b) (2 points) What would be the minimum width of the data address bus for TM4C123 and TM4C1294 with the above configuration when no additional external SRAM is connected?

- 2. The following program resides on the program memory of a TM4C123.
 - 1 MOV RO, #100 2 ADD R1, RO, #221 3 MOV R2, 0x0000.0200 4 STRH R1, [R2]
 - (a) (5 points) Rewrite the following program to execute in an ATmega128 preserving all considerations of general operation.
 - (b) (5 points) Draw the timing diagram for your program for ATmega128 mentioning the width of each bus.
- 3. (a) (10 points) Draw the schematic of a circuit for connecting a 3 × 4 keypad with an ATmega128 controller on PORTD using minimum number of pins. Clearly mention the electrical specification of each of the components to be used. The keyboard enters numbers 0-9 and special characters * and #.
 - (b) (10 points) Draw the flowchart and write down the AVR assembly language program for driving this circuit such that R16 stores the value of the scanned key and * corresponds to value of DEC(10) and # corresponds to DEC(11).
- 4. Implement a LED breathing light with a time period of 2 seconds such that in 1 sec it gradually brightens to maximum intensity and then in the next 1 sec gradually dims down with the cycle continuing. The ATmega128 is driven with a 16 MHz crystal oscillator.
 - (a) (6 points) Draw the circuit diagram clearly mentioning the electrical power rating of the components as well.
 - (b) (6 points) Draw the flow chart for implementing the program.
 - (c) (8 points) Write down the assembly program to implement this system.
- 5. (a) (5 points) Write a program to add the numbers stored in the data memory locations \$0240 \$0243 and store the resultant in \$0220 and \$0221 following little endian representation.
 - (b) (5 points) You have connected the PortB of two ATmega128 referred to as A and B. Draw the circuit diagram, flow chart and the code to transmit a 8-bit data from A to B in parallel transmit mode. Note that both A and B may be clocked at different oscillator frequencies, and so they may require handshaking protocol which may be incorporated using other available I/O pins as well.

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Name:

Roll no:

Fill up the answers on this sheet before submitting. Extra calculations, explanations and circuit diagrams if necessary are to be performed on the answer script and not on this sheet. Remember to fill in your name and roll no. before attempting any solution. Anonymous sheets will not be evaluated. Write all answers and draw plots or diagrams using a pen.

Detach this sheet and attach with answer script before submission.

6. Expand the following acronyms in the context of embedded systems.

(a)	(1 point)	JTAG
(b)	(1 point)	SRAM
(c)	(1 point)	NVRAM
(d)	(1 point)	AVR
(e)	(1 point)	DRAM
(f)	(1 point)	ASIC
(g)	(1 point)	OLED
(h)	(1 point)	ARM
(i)	(1 point)	LCD
(j)	(1 point)	GPIO

7. (a) (16 points) Write down the status of the following at the end of execution of each machine cycle when the following code is executed on an AVR microcontroller.

		R30	R31	SREG
1	LDI R30, 0x22		0x2E	
2	LDI R31, OxE4			0b10000001
3	ADC R31, R30			
4	SBIW R31:R30, 0x10			
5	SBIW R30:R31, 0x10			
6	EOR R31, R30			

(b) (4 points) The following assembly code is intended to be used for an AVR microcontroller. Identify the line numbers where a fault would occur and mention the type of faults.

1	LDI R16, 0x28
2	LDI R31, 0x37
3	MOV R2, R31
4	ADD R2, R31
5	ADC R2, R16
6	STS 0xF1, R5
7	LDS R6, 0xF2
8	OUT DDRB, R16
9	OUT B, R4
10	LDI R16, LOW(RAMEND)
11	OUT SPH, R16
12	LDS R8, OxF3
13	OUT C, R8
14	LDI R16, HIGH(RAMEND)
15	LDI R4, OxF1
16	OUT SPL, R16
17	PUSH R31
18	ADD R2, R31, R2
19	POP R22
20	ADC R2, R16
21	POP R23
22	OUT D, R23

Line numbers _____

Type of faults