

16-13

CMPE 127 Midterm Exam (Version B)
Spring 2016 Version B2

First Name

This test has total 20 points. Please be sure to provide a step-by-step result for the questions that involve calculation.

1. (5 points) Answer the following questions:

1.1 (1 point) What is the function of special purpose registers of ARM CPU (e.g., LPC1769), what is SSPICR0, how many bits are functionally usable for this register?

The purpose of the special purpose registers is to initialize and configure the peripheral for usage.

SSPICR0 is the control register which can allow for 16-bit data transfer.

1.2 (1 point) Given the following design requirement (technical specifications), use datasheet to fill in a binary pattern for (1) SPI interface; (2) 8 bit data packets; and (3) use other default clock settings to realize this interfaces (suppose SCR=28).

0 0

CR[15:8] - SCR

CR[3:0]

2⁸

2⁵

2⁴

2³

2²

2¹

2⁰

SCR

Binary

CR[3:0]

128 → 27

good

1.3 (1 point) Suppose SPI Flash serial interface is designed with 66Mhz clock rate, estimate the highest possible data read rate? Can it be used for 1024x768 8bit (5 frames per second) video display?

Yes

1024 x 768 x 8 x 5 =

3.2 MB

31,457,280

No

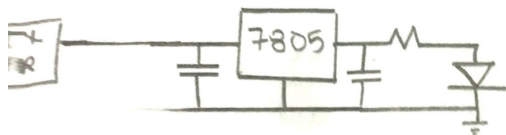
0.5

1.4 (1 point) In your prototyping board power unit design, LED is needed when the power connection is on, design a simple circuit to realize this function and calculate the resistor value if needed (Suppose I = 4mA)?

$$R = \frac{5 - 0.7}{4\text{mA}}$$

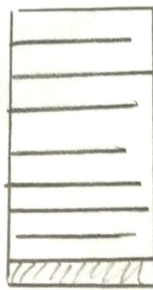
$$R = \frac{V_{CC} - V_{LED}}{I}$$

$$\Rightarrow \frac{4.3}{4 \times 10^{-3}} \Rightarrow R = \frac{4.3}{.004} \Rightarrow 1075 \Omega$$



1.5 (1 point) Suppose the address for SSPICR0 is 0x40030000, which memory bank holds this special purpose register? find the starting address of this memory bank?

Bank 0



0x4003 - 0000

[15:12]

32 bit Arch.

3.25/5

Starting Address

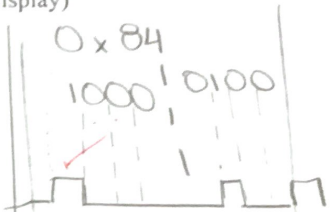
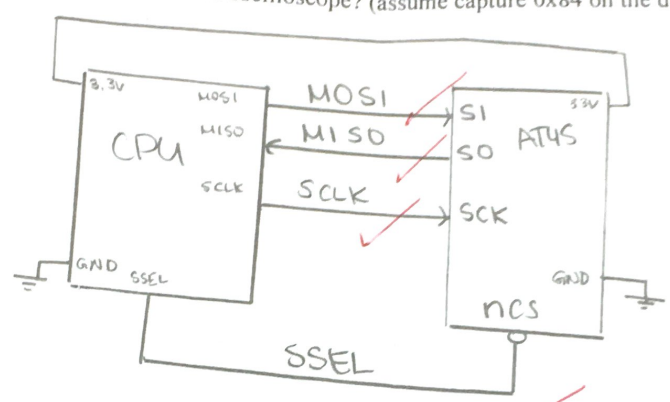
0x0000 - 0000

No

2. (5 points), Complete CPU to SPI serial flash interface design by answering the following questions:

- 2.1 (1 point) Name each of the SPI pin of the CPU for interface design?
- 2.2 (1 point) Design CPU to SPI serial flash interface by drawing detailed schematics, be sure to name each pin functionality (no pin number needed)?
- 2.3 (1 point) Draw a protocol timing diagram for SPI buffer write operation, use dashed line to divide them to 3 functional segments according to the SPI interface protocol, and explain the function for each segment?
- 2.4 (2 point) Then suppose using oscilloscope for debugging 0x84 opcode with $f=10\text{KHz}$, draw the opcode waveform (assume MSB out first), and if there are 5 grids, find the time dial of the oscilloscope? (assume capture 0x84 on the display)

4/5



$f=10\text{KHz}$

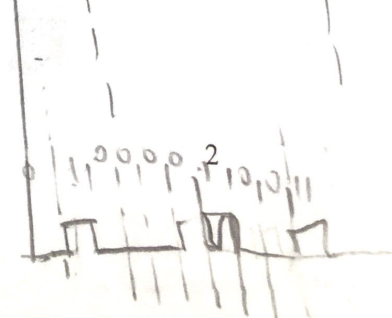
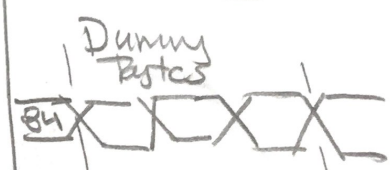
$$T = \frac{1}{10 \times 10^3} \rightarrow 1 \times 10^{-4}$$

~~1000~~ Time Dial
- 1 T/5

$$\frac{1}{10 \times 10^3} \Rightarrow 0.0001$$

$$\Rightarrow 1 \times 10^{-4}$$

$$T = 100 \mu\text{S}$$



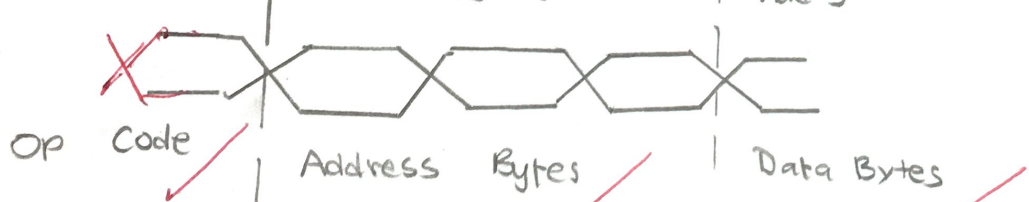
①

- MOSI \rightarrow Master Out slave In
- MISO \rightarrow Master In Slave Out
- SCLK \rightarrow synchronous clock
- SSEL \rightarrow slave select
- SI \rightarrow slave In
- SO \rightarrow slave out
- SCK \rightarrow synchronous clock
- ncs - chip select

② Field 1

Field 2

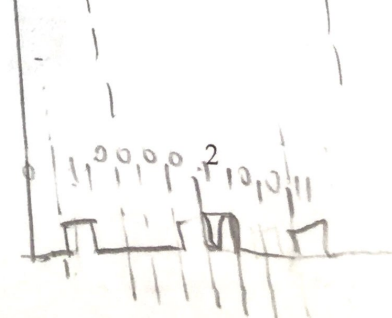
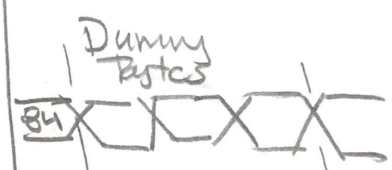
Field 3



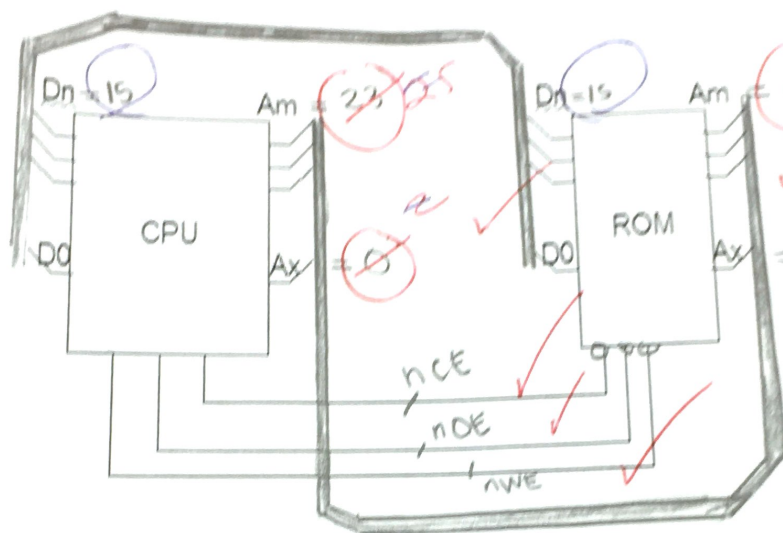
Op Code
 \uparrow
Op Code this enables you to decide what specific you want to perform.

Address Bytes
 \uparrow
These bytes are needed w/o the Op Code "Dummy Bytes"

Data Bytes
 \uparrow
This is the information you want to send.



3. (5 points) Given below is a unfinished ROM memory interface design, suppose (CPU) is on the left and ROM is on the right, answer the following questions.
- 3.1 (1 point) Suppose one ROM is 16 MB (8 bit data width), what is A_x ? And A_m ?
- 3.2 (3 points) If 64 MB ROM is to be designed with duplication of four ROMs above, find A_x ? And A_m ?
- 3.3 (1 point) Complete the schematic for 3.1 design with control signals, be sure to design the control signal with proper active high or active low (add small circle on each active low signal in your design).



Data - 8 bit.

3.1

$$16 \text{ MB} \Rightarrow 2^x \Rightarrow x=24 \checkmark$$

\uparrow \uparrow
 2^4 2^{20}

16 MB
 $2^4 \cdot 2^{20} = 2^{24}$

$A[23:0] \quad a_{23} a_{22} \dots a_0$

$$A_m = 23$$

$$A_x = 0$$

3.2

$$64 \text{ MB ROM} \Rightarrow 2^x \Rightarrow x=26 \checkmark$$

\uparrow \uparrow
 2^6 2^{20}

$x=26$

$$a_{25} a_{24} a_{23} \dots a_3 a_2 a_1 a_0$$

$$A_m = 25 \checkmark$$

$$A_x = 2 \checkmark$$

3.3

control signal
all active low signals

nCE
nOE
nWE

4.5/5

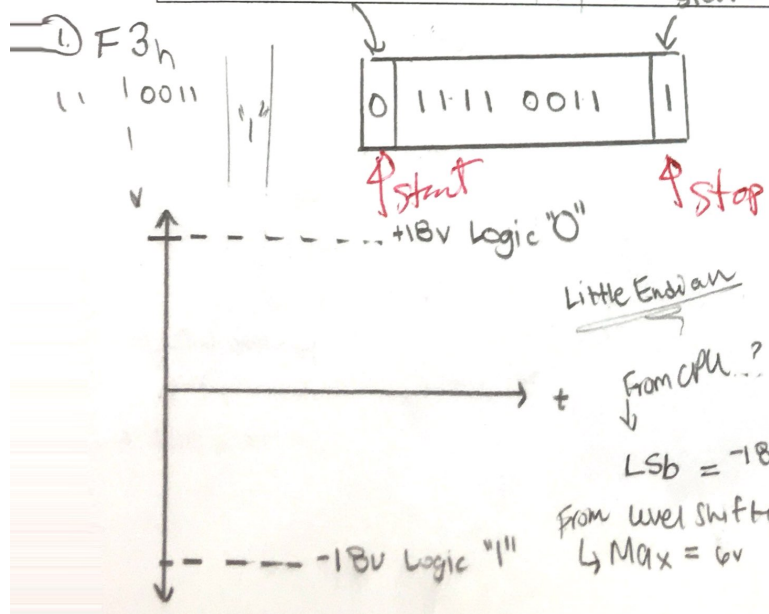
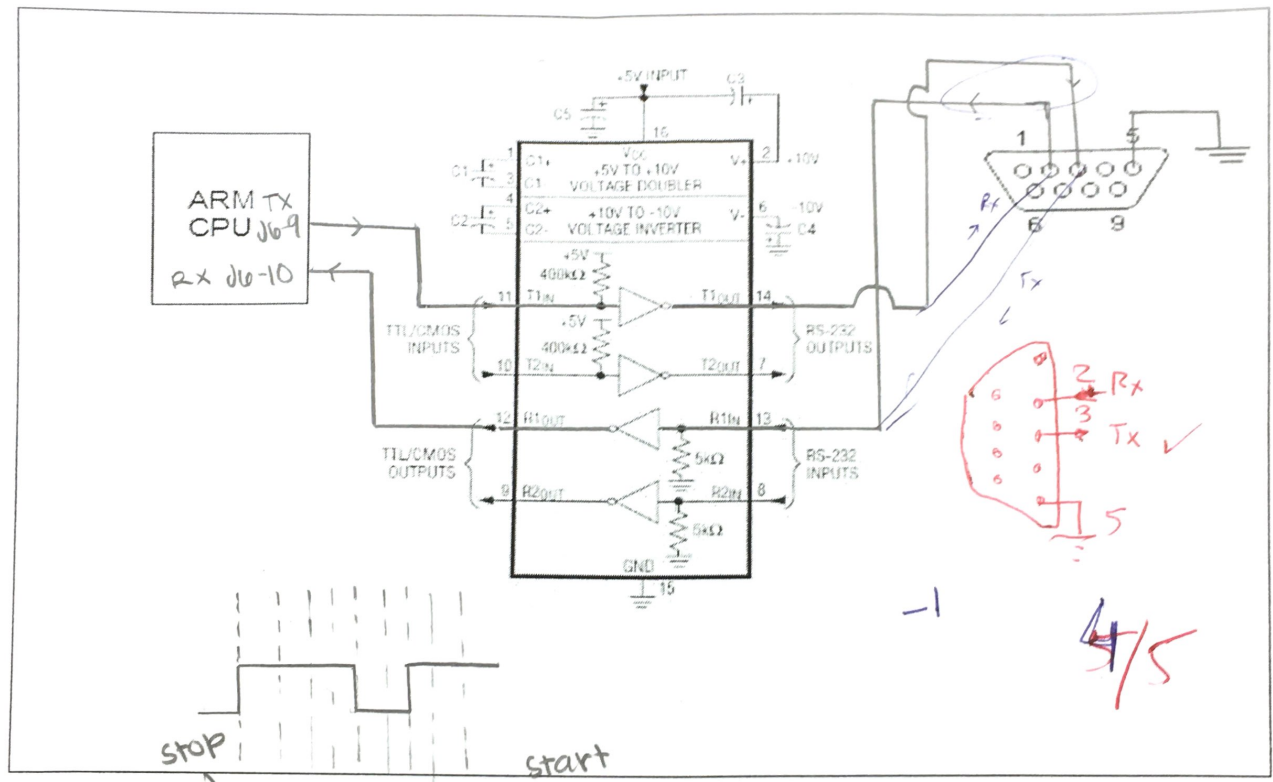
uses differential voltage
 Logic "1" $\rightarrow \sim -18V$
 Logic "0" $\rightarrow \sim +18V$

always little endian

4. (5 points) RS232 serial interface is one of the key interfaces for debugging the microprocessor system, based on the system block diagram below, answer the following questions:

- 4.1 (1 pt) Suppose a letter with hex 0xF3 to be send, what is the first bit (LSB) voltage value at CPU TX? And what is the voltage value at MAX T_{out}?
 4.2 (2 pts) complete the un-finished design below (a) draw the pins with a proper pin functional name for Tx and Rx of the CPU; (b) form serial interface lines by connecting these pins to MAX232; (c) then connect the MAX232 output to DB9 connector (assume the connector is the one on your prototype board, not on the host computer side, and assume null modem cable is used).
 4.3 (2 pts) Find the time interval for a single bit for 115200 bps communication? Find the time needed to send this letter?

DB 9
 Pin 2 (Rx) Pin 3 (Tx)



4.3 115200 bps

$$T = \frac{1}{f} \Rightarrow \frac{1}{115200 \text{ bps}}$$

$T = 8.681 \mu s$ ← time for one bit

RS232 sends 10 bits

So Time for the whole word

→ $8.681 \mu s \times 10$