BBM 432 - Gömülü Sistemler **Name:** ____________________

Bahar 2016-2017

Final

24/5/2017

Süre: 120 Dakika

The exam consists of 5 questions.

Grade Table (for instructor use only)

Question	Points	Score
1	15	
2	10	
3	10	
4	20	
5	15	
Total:	70	

1. In a robot project, you will use a distance measuring sensor. The distance-voltage characteristic of the sensor is given in the next page. You would like to be able to measure distances between 4 cm to 40 cm. Your ADC range is between 0 and 3.3V similar to your microcontroller TM4C. You have a 4-bit ADC.

   (a) (5 points) You read a value of 1010 from your 4-bit ADC, what is the actual distance?

   (b) (5 points) Assume that the distance never reduces below 4 cm. What is the approximate worst-case accuracy of your system in cm? Note that the accuracy is not same for different distances. Show your work on the graph.

   (c) (5 points) Let's assume that you have a different very high resolution ADC which gives you very precise measurements of distance. Also assume that the response time of the sensor is very low. You have a fast moving robot around the wall. The maximum speed of the robot is 25 cm per second. To capture the change of distance to the wall with better than 1 cm accuracy in the worst-case what should be the minimum sampling rate of your ADC.

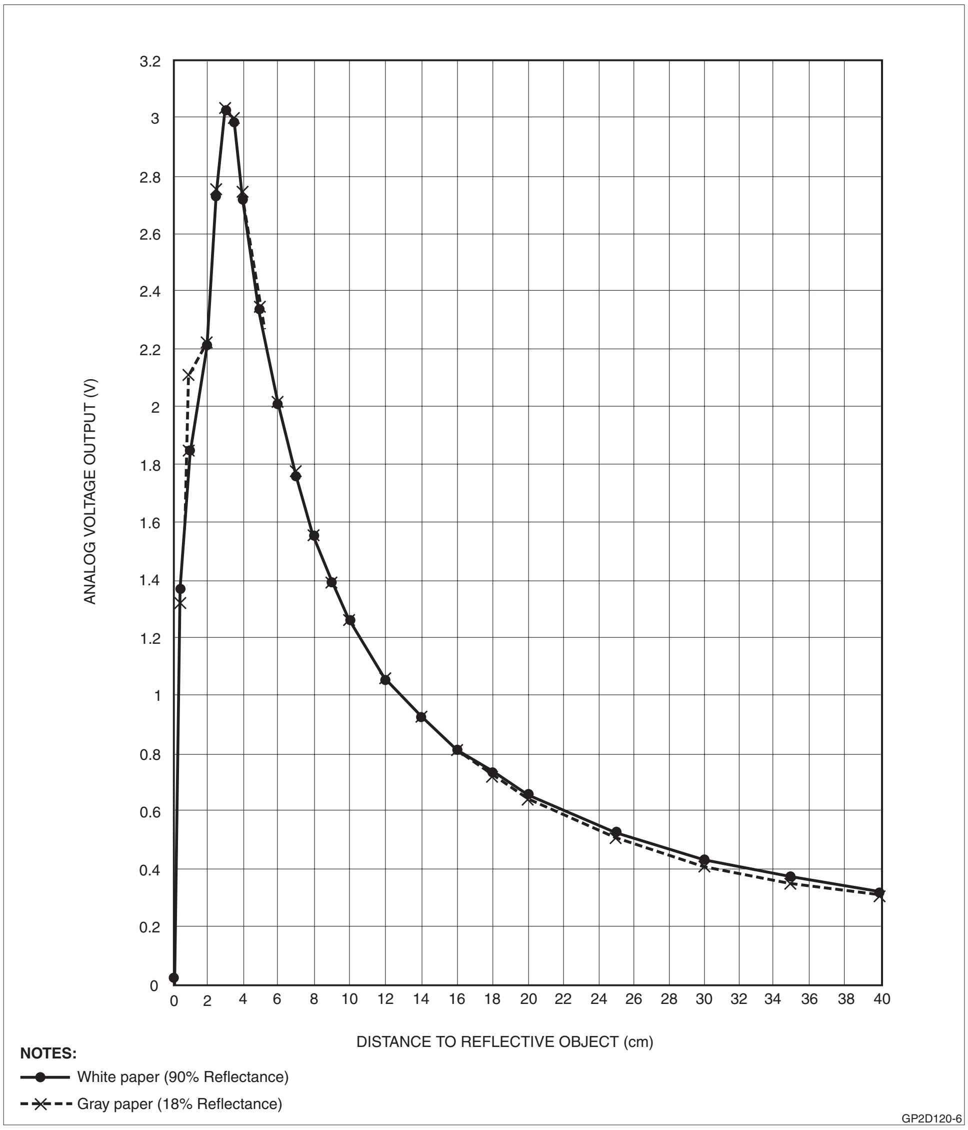
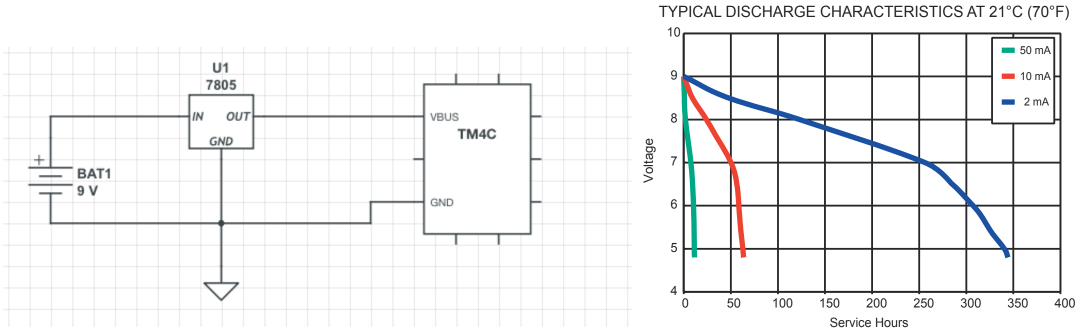


Figure 4. GP2D120 Example of Output Distance Characteristics

2. (10 points) Below there is a circuit diagram which powers your microcontroller TM4C via a 9V battery. The linear regulator 7805 is used to convert 9V to 5V. The battery discharge characteristics and the a part of the datasheet of 78xx regulators is also given. Assume that your circuit constantly draws 2mA of current from the 9V battery. Assume that TM4C requires strictly 5V from the VBUS pin. What is the lifetime of your system? Explain your reasoning.



Şekil 1: Circuit diagram

μA7800 SERIES
POSITIVE-VOLTAGE REGULATORS

SLVS056J – MAY 1976 – REVISED MAY 2003

recommended operating conditions

			MIN	MAX	UNIT
V_I	Input voltage	μA7805C	7	25	V
		μA7808C	10.5	25	
		μA7810C	12.5	28	
		μA7812C	14.5	30	
		μA7815C	17.5	30	
		μA7824C	27	38	
I_O	Output current			1.5	A
T_J	Operating virtual junction temperature	μA7800C series	0	125	°C

electrical characteristics at specified virtual junction temperature, V_I = 10 V, I_O = 500 mA (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_J†	μA7805C MIN	TYP	MAX	UNIT
Output voltage	I_O = 5 mA to 1 A, V_I = 7 V to 20 V, $P_D \le$ 15 W	25°C	4.8	5	5.2	V
		0°C to 125°C	4.75		5.25	
Input voltage regulation	V_I = 7 V to 25 V	25°C		3	100	mV
	V_I = 8 V to 12 V			1	50	
Ripple rejection	V_I = 8 V to 18 V, f = 120 Hz	0°C to 125°C	62	78		dB
Output voltage regulation	I_O = 5 mA to 1.5 A	25°C		15	100	mV
	I_O = 250 mA to 750 mA			5	50	
Output resistance	f = 1 kHz	0°C to 125°C		0.017		Ω
Temperature coefficient of output voltage	I_O = 5 mA	0°C to 125°C		–1.1		mV/°C
Output noise voltage	f = 10 Hz to 100 kHz	25°C		40		μV
Dropout voltage	I_O = 1 A	25°C		2		V
Bias current		25°C		4.2	8	mA
Bias current change	V_I = 7 V to 25 V	0°C to 125°C			1.3	mA
	I_O = 5 mA to 1 A				0.5	
Short-circuit output current		25°C		750		mA
Peak output current		25°C		2.2		A

† Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-μF capacitor across the input and a 0.1-μF capacitor across the output.

Şekil 2: A part of the 78xx series datasheet.

3. (10 points) Design a 3-bit DAC using multiple 10k resistors. No values other than 10k are allowed.

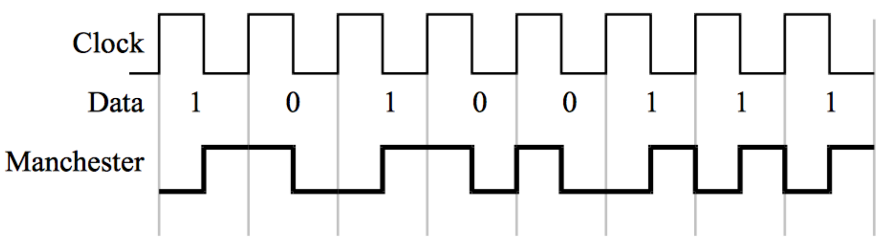
4. A stepper motor can be controlled by writing a 4-bit number to it. The repeating sequence 5,6,10,9,5,6,10,9... moves it clockwise (CW) and the repeating sequence 5,9,10,6,5,9,10,6... moves it counter clockwise (CCW). The delay between writes determines the speed of the motor. Assume a constant speed of the motor with time between writes of 50ms.

   (a) (10 points) Design a Moore FSM with four states that takes a single input PA0 (0:CW; 1:CCW) and four outputs (PD0-3).

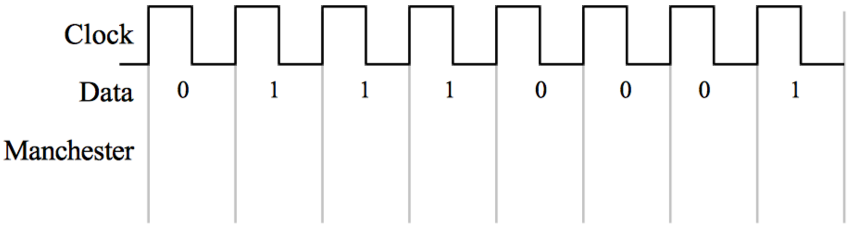
(b) (10 points) Complete the code below by adding state defines and FSM array entries and the FSM loop.

```
struct State{
  uint8_t out;   // output produced in this state
  uint32_t wait; // delay in 10us units
  uint8_t next[4]; // list of next states
};
typedef struct State SType;
SType FSM[4] = {




}
SType curState =     ; //set the initial state here int main() {
// All Port Initialization done for you - Ccomplete the FSM loop below ...
while(1){










         }
}
```

5. You are hired to design communication software for an embedded system. Your job is to implement the software logic for transmitting data using "Manchester encoding," a method to transmit bits between sender and receiver systems using edge transitions. You are given a "transmission Clock" (an input to the controller, separate from the CPU clock) and a Data value (e.g., 10100111). You have to generate a Manchester Output waveform on a port pin. In general Manchester encoding follows Clock XOR Data= Manchester Output



(a) (5 points) Assuming you want to transmit the 8-bit data sequence 01110001, draw a similar diagram to the above showing the corresponding Manchester output.



(b) (10 points) You will write a routine that transmits 8 bits of data in C. The input to this function is an 8-bit unsigned byte containing the data to be transmitted. The Clock input is connected to PA1, and the Manchester output is connected to PA0. Assume software has already initialized PA1 and PA0 as input and output respectively. To send one bit: wait for the Clock to be high high, set the PA0 output to (Data XOR Clock), wait for the Clock to be low, and then set the PA0 output to (Data XOR Clock). To send one byte repeat this bit-procedure 8 times, once for each bit. Output the most significant bit first. Your code need not be friendly. Do not use interrupts, instead use polling.

```
void Manchester(uint8_t data){




}
```