L-3/T-2/CSE **Date : 07/08/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2014-2015

Sub : **CSE 315** (Microprocessors and Micro-controllers)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Explain what determines whether a μP is a 16-bit or 32-bit device. **(8)**

   (b) Discuss briefly 80286 protection mechanism. **(20)**

   (c) How many modes of operation are there in 80286? How can you switch back and forth between them? **(7)**

2. (a) What are different types of interrupts available in 8086? Briefly describe the interrupts of 8086 pre-defined by INTEL. **(5+10)**

   (b) List and describe the steps of INTEL microprocessor will take when it response to an external interrupt. **(13)**

   (c) What addresses in the interrupt-vector table are used for a Type 4 interrupt? **(7)**

3. (a) Discuss 80286 segment descriptor. **(15)**

   (b) Discuss virtual mode of operation of 80386. **(8)**

   (c) Discuss 80386 paging scheme. **(12)**

4. (a) Discuss how internal architecture of Pentium Pro is different from that of earlier μProcessors. **(15)**

   (b) Write short notes on (i) Pentium II and (ii) Pentium III. **(10+10)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

Find the pin diagram of ATmega32 microcontroller and its different register configuration at the end of the questions.

5. (a) Suppose in a particular project an ATmega32 microcontroller needs to communicate with four different devices. So you have to connect these four devices with ATmega32. Now answer the following questions: **(15)**

   (i) Which serial communication protocol allows you to connect these four devices to the microcontroller using the minimum number of wires?

   (ii) What are the preconditions for using the serial communication protocol asked in question 5(a)(i)?

   (iii) Draw a block diagram showing the required connections among the devices if the serial communication protocol asked in question 5(a)(i) is used? You must label those pins of ATmega32 that will be used for the connection.

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Contd... Q. No. 5

(b) Suppose, MCAM100 is a programmable pan-tilt video camera. It can be controlled using UART (Universal Asynchronous Serial Receiver & Transmitter). You have to use USART of Atmega32 microcontroller to rotate the camera repeatedly. The required connection parameters are: 8 data bit (code: 011), 1 stop bit (code: 0), no parity bit (code: 00), baud rate 9600 bps and asynchronous mode (code: 0). Sending character 'L' or 'R' will turn the camera left or right respectively. Assume the system clock frequency of ATmega32 is 1 MHz. Now answer the following questions: **(20)**

(i) Calculate the appropriate value for UBRR (USART Baud Rate Register).

(ii) Write a C function named **USART init** which initializes ATmega32 USART for the given parameters.

(iii) Write a C function named **USART send** which sends a character through ATmega32 USART using polling.

(iv) Write the main function which continuously does the following things:

a. Rotate the camera left for 5 times. Give 500 milliseconds delay between each successive left rotation.

b. Rotate the camera right for 5 times. Give 200 milliseconds delay between each successive right rotation.

6. (a) Consider the following C program for Atmega32 microcontroller: **(18)**

```
1.  #include <avr/io.h>
2.  int main(void)
3.  {
4.        unsigned char mask = 1<<TOV1;
5.        TCCR1A = 0b00000000; // Timer1 Normal mode
6.        while(1)
7.        {
8.              TCNT1 = 0xFFF2;
9.              TCCR1B = 0b00000001; // no prescaling,
10.             while(!(TIFR & mask)); // delay
11.             TCCR1B = 0;
12.             TIFR = mask;
13.       }
14. }
```

Answer the following questions considering this program:

(i) Calculate the amount time delay (in μsec.) caused by line 10. You have to justify your calculation. Assume that system clock frequency is 8 MHz. Do not consider the clock cycles needed to execute machine instructions.

(ii) What is the effect of line 11 on Timer1?

(iii) What is the effect of line 12 on Timer1?

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Contd... Q. No. 6

(b) Consider the following C program which is running on an ATmega32 microcontroller: **(17)**

```
1.  #include <avr/io.h>
2.  #include "avr/interrupt.h"
3.  unsigned char d = 31;
4.  ISR (TIMER1_COMPA_vect)
5.  {
6.        d = ~d;
7.        OCR1A = d;
8.  }
9.  int main(void)
10. {
11.     DDRD = 1<<5; //Set PD5 as output
12.     OCR1A = d;
13.     TCCR1A = 0b11000001; //inverted mode: Set on match,clear on TOP
14.     TCCR1B = 0b00001001; //Fast PWM, TOP=0xFF, no prescaling
15.     TIMSK = (1<<OCIE1A); //enable output compare A match interrupt
16.     sei();
17.     while (1);
18. }
```

Draw the waveform generated by pin PD5 (OC1A) i.e. pin 19. Represent time in μsec. using the horizontal axis and represent voltage using the vertical axis. Assume that the time is 0 when Timer1 starts counting. You have to draw the waveform upto 1024 μsec. System clock frequency = 1 MHz.

Hints: In Fast PWM mode, when we write a value into the OCR1A register, the value will not be loaded into OCR1A until TCNT1 reaches its TOP.

7. (a) Suppose you need to sample an analog signal precisely at sampling frequency 20000 kHz using the on-chip ADC peripheral of ATmega32 microcontroller. Assume system clock frequency = 16 MHz and Timer0 prescaler = 8. Answer the following questions: **(20)**

   (i) How can you use Timer0 Compare Match event of ATmega32 to ensure proper ADC conversion timing? Mention the ADC registers that must be properly configured for this purpose?

   (ii) Calculate the appropriate value of OCR0 register.

   (iii) Calculate the **optimal** value of ADC prescaler.

   (iv) How many ISRs you need to write for this purpose? Draw the flowchart for each ISR.

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Contd... Q. No. 7

(b) Consider the following C program for ATmega32 microcontroller: **(15)**

```
1.  #include <avr/io.h>
2.  #include <avr/interrupt.h>
3.  #include <avr/sleep.h>
4.  #define MAX 60
5.  volatile unsigned char sleepNow = 0;
6.  unsigned char ovfCount = 0;
7.  ISR(TIMER1_OVF_vect)
8.  {
9.        if (ovfCount < MAX)
10.       {
11.             ovfCount++;
12.       }
13.       else
14.       {
15.             sleepNow = 1;
16.       }
17. }
18. ISR(INT0_vect)
19. {
20. }
21. int main(void)
22. {
23.       DDRD &= ~ ( 1  << PD2 );  // INT0: input ...
24.       PORTD |=  ( 1  << PD2 );  // Enable pullup.
25.       // Level interrupt INT0 (low level)
26.       MCUCR &= ~ ( ( 1  << ISC01 )  |  ( 1  << ISC00 ) );
27.       GICR = GICR | (1<<INT0);
28.       TCCR1A = 0b00000000; // normal mode
29.       TCCR1B = 0b00000001; // no prescaler, internal clock
30.       TIMSK = 0b00000100; // Enable Overflow Interrupt
31.       set_sleep_mode(SLEEP_MODE_PWR_DOWN);
32.       sei();
33.       while (1)
34.       {
35.             cli();
36.             if (sleepNow == 1)
37.             {
38.                   sleep_enable();
39.                   sei();
40.                   sleep_cpu();
41.                   sleep_disable();
42.                   sleepNow = 0;
43.                   TCNT1 = 0;
44.             }
45.             sei();
46.       }
47. }
```

In this program, ATmega32 is placed into a sleep mode when a certain condition is met to reduce power consumption. Answer the following questions considering this program:

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Contd... Q. No. 7(b)

(i) When ATmega32 will be placed into sleep mode?

(ii) How ATmega32 can be waked up from this sleep mode?

(iii) What is the first thing done by ATmega32 after waking up from sleep?

(iv) Which clock domains ($clk_{I/O}$, clk_{ADC}, clk_{CPU}, clk_{FLASH}, clk_{ASY}) will be active during this sleep mode?

(v) What is the function of line 38 and 40? What is the effect of removing line 39 from the program?

8. (a) Consider the following CUDA program: **(17)**

```
1.  #include <stdio.h>
2.  #include "cuda_runtime.h"
3.  #include "device_launch_parameters.h"
4.  #define ARRAY_SIZE 10
5.  float h_in[ARRAY_SIZE];
6.  float h_out[ARRAY_SIZE];
7.  // the kernel
8.  __global__ void vecSquare(float * in , float * out, int n)
9.  {
10.       int i = threadIdx.x;
11.       if(i < n)
12.       {
13.            out[i] = in[i] * in[i];
14.       }
15. }
16. int main()
17. {
18.       const int ARRAY_BYTES = ARRAY_SIZE * sizeof(float);
19.       // generate the input array on the host
20.       for(int i=0; i<ARRAY_SIZE; i++)
21.       {
22.            h_in[i] = float(i);
23.       }
24.       // declare GPU memory pointers
25.       float * d_in;
26.       float * d_out;
27.       // allocate GPU memory
28.       cudaMalloc( &d_in, ARRAY_BYTES);
29.       cudaMalloc( &d_out, ARRAY_BYTES);
30.       // transfer the array to the GPU
31.       cudaMemcpy(d_in, h_in, ARRAY_BYTES, cudaMemcpyHostToDevice);
32.       // launch the kernel
33.       vecSquare<<< 1,ARRAY_SIZE >>>(d_in,d_out, ARRAY_SIZE);
34.       // copy back the result array to the CPU
35.       cudaMemcpy(h_out, d_out, ARRAY_BYTES, cudaMemcpyDeviceToHost);
36.       // free GPU memory allocation
37.       cudaFree(d_in);
38.       cudaFree(d_out);
39.       return 0;
40. }
```

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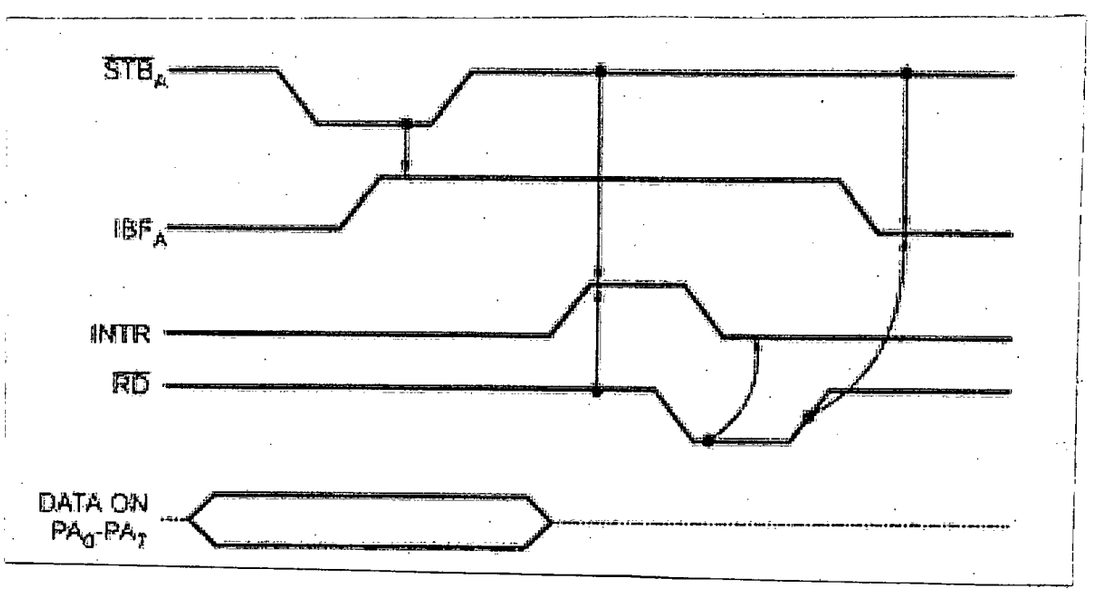
Contd... Q. No. 8(a)

This program performs square of each array element using NVIDIA GPU. Answer the following questions considering this program:

(i) If you run this program varying the value of ARRAY_SIZE (defined in line 4), you would notice that this program successfully works for ARRAY_SIZE upto 1024. What is the reason for this? **Hints:** A thread block can contain maximum 1024 threads.

(ii) Modify this program so that it can work for arbitrary value of ARRAY_SIZE. Rewrite the complete program.

(b) Suppose, 8086 is reading data bytes from a tape reader through Port A of the 8255 using strobed input mode. The timing diagram for one byte of data transfer is given below: **(18)**



Now consider the following list of events:

Event ID	Event description
1.	Data byte from tape recorder is no more valid.
2.	8255 forbids tape recorder to send the next data byte.
3.	8255 signals tape recorder that it is now safe to send the next data byte.
4.	8255 loads the data byte into the input latch of Port A.
5.	8255 informs 8086 about the reception of data using interrupt.
6.	8086 starts reading the data

Redraw the timing diagram and mark the first occurrence of each event with the corresponding event ID surrounded by a circle on the timing diagram.

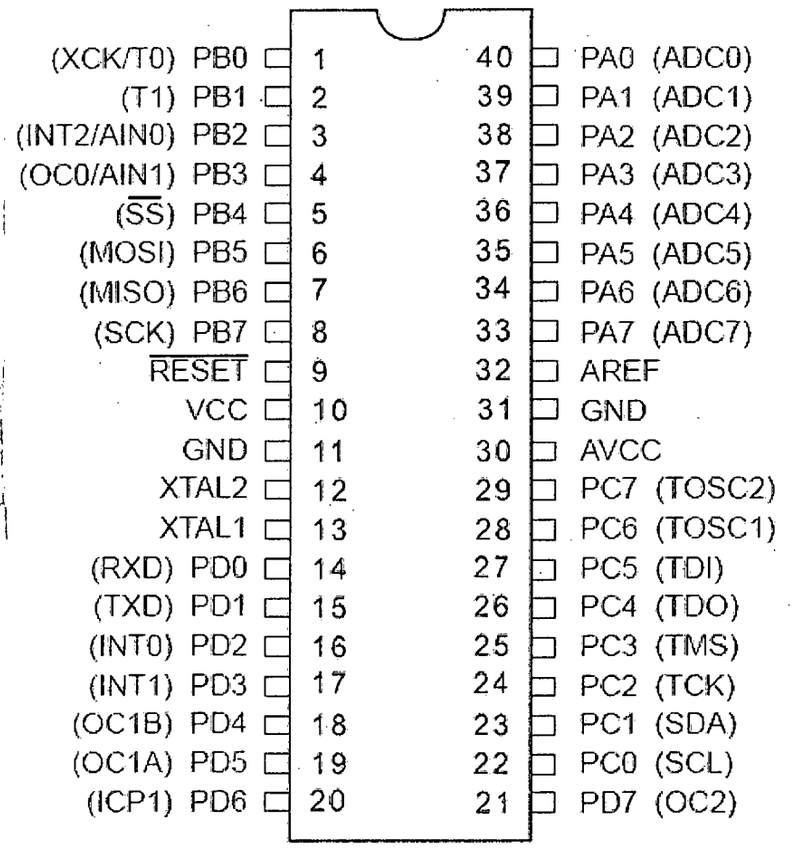


Figure 1: ATmega32 pin diagram

Register Name	Configuration							
GICR	INT1	INT0	INT2	-	-	-	IVSEL	IVCE
MCUCR	SE	SM2	SM1	SM0	ISC11	ISC10	ISC01	ISC00
MCUCSR	JTD	ISC2	-	JTRF	WDRF	BORF	EXTRF	PORF
TCCR1A	COM1A1	COM1A0	COM1B1	COM1B0	FOC1A	FOC1B	WGM11	WGM10
TCCR1B	ICNC1	ICES1	-	WGM13	WGM12	CS12	CS11	CS10
TIMSK	OCIE2	TOIE2	TICIE1	OCIE1A	OCIE1B	TOIE1	OCIE0	TOIE0
TIFR	OCF2	TOV2	ICF1	OCF1A	OCF1B	TOV1	OCF0	TOV0
UCSRA	RXC	TXC	UDRE	FE	DOR	PE	U2X	MPCM
UCSRB	RXCIE	TXCIE	UDRIE	RXEN	TXEN	UCSZ2	RXB8	TXB8
UCSRC	URSEL	UMSEL	UPM1	UPM0	USBS	UCSZ1	UCSZ0	UCPOL
ADCMUX	REFS1	REFS0	ADLAR	MUX4	MUX3	MUX2	MUX1	MUX0
ADCCSRA	ADEN	ADSC	ADATE	ADIF	ADIE	ADPS2	ADPS1	ADPS0
SFIOR	ADTS2	ADTS1	ADTS0	-	ACME	PUD	PSR2	PSR10

Table 1: List of ATmega32 registers

Figure for Q. No. 5 & 7

L-3/T-2/CSE **Date : 17/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2014-2015

Sub : **CSE 321** (Computer Networks)

Full Marks: 280 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Two military troops want to exchange highly-sensitive information between them. Here, both the troops need to ensure secrecy of the exchanged information while the information is under communication, i.e., no intruder can interpret any information under communication. Alongside, both the troops need to ensure that the information can be received only from the other troop, i.e., only from the authenticated source. Finally, both the troops want to ensure that the mode of information exchange will retain the capability of non-repudiation, i.e., a sender cannot refute after sending its own information. To meet all these requirements, both the troops agree on using message digests. **(23⅔)**

Now, you need to assess whether the choice of message digests is sufficient enough to meet all the requirements. If you think that the choice of message digests is sufficient enough, then you need to elaborate how the choice meets all the requirements. If not, then you need to state why the choice does not meet the requirements and what other possible alternative(s) (with brief elaboration) could be used in place of message digests.

(b) Authentication between two parties can be done using a notion of two-way challenge-response protocol. The protocol may need five different information exchanges, which can be minimized to three information exchanges. However, irrespective of the number of information exchanges, a shared key needs to be established between the communicating parties. Diffie-Hellman key exchange mechanism can assist to establish a shared key between the communicating parties. **(23)**

One of the prominent vulnerabilities of the Diffie-Hellman key exchange mechanism is that it is prone to Bucket-Bridge or Man-In-The-Middle attach. In such an attack, an intruder can get into the two parties that want to establish a shared key. To alleviate this vulnerability (i.e., the Bucket-Bridge or Man-In-The-Middle attack), a researcher proposes to utilize a timestamp and a random number that will be used only once (or nonce in its general term). Do you think the usage of a timestamp and a nonce is justified to guard against the Bucket-Bridge or Man-In-The-Middle attack? If so, then you need to elaborate how the usage of a timestamp and a nonce can guard against the attack. If you think that the usage of a timestamp and a nonce is not justified to guard against the attack, then you need to elaborate why it is not justified.

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2. (a) The IEEE 802.11 protocol operates in two different modes - Distributed Co-ordination Function (DCF) and Point Co-ordination Function (PCF). In DCF, 802.11 uses CSMA/CA. Here, two types of channel sensing are generally used - Physical channel sensing and Virtual channel sensing. You need to elaborate the methodology of the Virtual channel sensing. Here, you also need to elaborate how it operates in case of having fragments of a frame. **(23⅔)**

(b) Bridges are used for switching in Data Link Layer to connect different LANs. To make Bridges plug-n-play, i.e., start operating from the time of connecting it without any more configurations being required, the notion of Transparent Bridge is widely use. In Transparent Bridges, paths to different LANs are learned through backward learning or tracing the reverse path of an incoming frame. Here, if the destination of a frame remains unknown, then the notion of flooding is used. Such mechanism can create a problem with experiencing infinitely looping frames in case of having two parallel transparent bridges between two different LANs or having a similar kind of topology. **(23)**

To alleviate the problem of experiencing infinitely looping frames, a potential countermeasure could be to operate over an overlay spanning tree. Here, the tree is formed from a graph that is constructed through taking each bridge as a node and each LAN as a link. Do you think that this countermeasure will be a workable solution? If so, then you need to elaborate how it gives a workable solution with an example. If you think that this countermeasure will not be a workable solution, then you need to elaborate reason(s) behind your thoughts and how the solution could be made workable.

3. (a) One of the good sides of CDMA is that it allows each station to transmit over the entire frequency spectrum all the time. This good side is completely missing in many similar other techniques such as AMPS, D-AMPS, and GSM. This happens as these techniques demand multiplexing over the contending stations in the time domain. Consequently, many a times CDMA is found to perform better than these techniques. **(23⅔)**

Now, let a new solution come up to overcome the barrier AMPS, D-AMPS, GSM, and similar techniques experience while multiplexing accesses of contending stations in the time domain. The solution attempts to enable each station to transmit over the entire frequency spectrum all the time through utilizing the concept of Hamming distance. It utilizes the condition that d-bit error can be corrected through ensuring a minimum of (2d+1) Hamming distance among the allowed codewords. It separately enables the same mechanism for both cases - while the medium experiences single-bit error and while the medium experiences burst errors.

Now, you need to judge the success scenario of the new solution. You need to answer whether the new solution can succeed or not. If yes, then elaborate why and how this succeeds. If not, then elaborate what is the reason behind its failure.

Contd P/3

(b) A company has several branches all over the world. The branches communicate among themselves over a network containing network devices (such as switches, routers, etc.) that can fail individually at any time without offering any high level of reliability. Besides, the branches do not demand any fixed bandwidth for communicating among themselves. Alongside, the branches do not need in-order arrival of the packets under communication. **(23)**

Now, to meet these requirements, you need to choose the appropriate mode of communication between two conventional modes - packet switching and circuit switching. You need to justify your choice and elaborate the underlying communication mechanism of the choice.

4. (a) Adaptive Tree Walk protocol is one of the classical examples of limited-contention protocol. Here, each station is considered as a leaf of a binary tree. The protocol generally begins from the root of the tree and traverses the tree according to what happens while being at a node. The protocol gives changes to all stations under the currently-traversing node to initiate their communications. **(23⅔)**

Now, you are given a task to optimize the traversal mechanism through not starting from the root of the tree. You need to elaborate how you can do it with necessary example(s).

(b) "In one-bit sliding window protocol, there can be duplicated packets in communication" - validate or invalidate this statement with necessary example(s) and elaboration. **(23)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Draw a block diagram to show the operation of SSL. Why is HTTPS not used for all web traffic? Discuss possible weaknesses in the implementation of HTTPS. **(20)**

(b) Name four common types of DNS query. Show the DNS operation for a site, say, www.yahoo.com with diagram when the local DNS server does not have this URL in its cache. **(16⅔)**

(c) Discuss DNS spoofing attack in brief. **(10)**

6. (a) Show DHCP operation. When is DHCP preferred and when is it not compared to static addressing? How does a Rough DHCP Server cause security threat? **(16⅔)**

(b) What is TCP handoff? Discuss different uses and abuse of cookie mechanism. **(20)**

(c) Compare H.323 with SIP. **(10)**

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7. (a) What is delayed duplicate problem in the context of connection establishment? How does three-way handshake solve it? **(12)**

(b) Discuss dynamic buffer allocation at transport layer. Show a potential problem of this technique. What are the limitations of RPC? **(18)**

(c) How is retransmission timeout calculated dynamically in TCP? What potential problem may occur in this scheme? **(16⅔)**

8. (a) What is persistence timer in TCP? What is the purpose of PSH and URG bits in TCP header? Why Nagle's algorithm used in TCP implementations? When can't this algorithm be used? **(18)**

(b) Discuss count to infinity problem in brief in the context of distance vector routing. Discuss the sue of source port field in NAT. **(10)**

(c) Where should we place standard and extended ACLs and why? For a given network address 10.10.128.0/17, you need to create subnets such that at most 400 hosts can be accommodated in one subnet. Determine the range of usable host addresses and broadcast address in dot decimal notation for the last subnet. **(18⅔)**

L-3/T-2/CSE **Date : 23/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2014-2015

Sub : **CSE 301** (Mathematical Analysis for Computer Science)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Deduce the maximum number of regions n planes can divide the 3-D space. **(15)**

   (b) Let us have Josephus problem where among n persons every 9th person is deleted, and let $J_q(n)$ be the ultimate survivor. Deduce $J_q(n)$ and computed $J_8(1000)$. **(20)**

2. (a) Discuss multiple Tower of Hanoi problem. Deduce the properties of the Presumed Optimal Solution: Solve the problem for n = 378 and p = 8 showing the solution in a binary tree of level 2. **(15)**

   (b) Discuss the properties of finite calculus with examples. Compute the value of $\sum_{0\le k<n} k^2 H_k$. **(20)**

3. (a) Using combinatorial arguments establish the identities **(15)**

$$\sum_{0\le k \le n} \binom{k}{m} = \binom{n+1}{m+1}$$

$$\binom{n-1}{k} + \binom{n-1}{k-1} = \binom{n}{k}$$

   (b) If n men throw their hats and randomly picks up hats. In how many ways can they end up in receiving wrong hats? Use inversion formula to deduce the results. **(20)**

4. (a) Discuss Stirling numbers in detail and deduce recurrence relations they satisfy. **(15)**

   (b)(i) Discuss Harmonic numbers with their properties. Calculate maximum overhang that can be created by placing n cards on n table. **(20)**

   (ii) Discuss Euler number and establish recurrence relations it satisfies.

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SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Suppose that two teams are playing a series of games, each of which is independently won by team A with probability p and by team B with probability $1-p$. The winner of the series is the first team to win i games. Find the expected number of games that are played with (i) $i = 2$, and (ii) $i = 3$. **(5+5)**

(b) A gambler has in his pocket a fair coin and a two-headed coin. He selects one of the coins at random, and when he flips it, it shows heads. What is the probability that it is the fair coin? Suppose that he flips the same coin a second time and this time it shows tail. Now what is the probability that it is the fair coin? **(5+5)**

(c) Define moments of a Random Variable. How can we obtain them from moment generating function? Derive the moment generating function for the Poisson distribution with parameter λ? If X and Y are independent Poisson random variables with parameters λ_1 and λ_2, respectively, then what is the distribution of $X+Y$? **(2+3+5+5)**

6. (a) Each element in a sequence of binary data is either 1 with probability p or 0 with probability $1-p$. A maximal subsequence of consecutive values having identical outcomes is called a run. For instance, if the outcome sequence is 1, 1, 0, 1, 1, 1, 0, the first run is of length 2, the second is of length 1, and the third is of length 3. **(6+6)**

   (i) Find the expected length of the first run.

   (ii) Find the expected length of the second run.

(b) In an election, candidate A receives n votes, and candidate B receives m votes where $n > m$. Assuming that all orderings are equally likely, show that the probability that A is always ahead in the count of votes is $(n-m)/(n+m)$. **(11)**

(c) A prisoner is trapped in a cell containing three doors. The first door leads to a tunnel that returns him to his cell after two days of travel. The second leads to a tunnel that returns him to his cell after three days of travel. The third door leads immediately to freedom. **(6+6)**

   (i) Assuming that the prisoner will always select doors 1, 2, and 3 with probabilities 0.5, 0.3, 0.2, what is the expected number of days until he reaches freedom?

   (ii) Assuming that the prisoner is always equally likely to choose among those doors that he has not used, what is the expected number of days until he reaches freedom? (In this version, for instance, if the prisoner initially tries door 1, then when he returns to the cell, he will now select only from doors 2 and 3.)

Contd P/3

CSE 301

7. (a) A certain town never has two sunny days in a row. Each day is classified as being either sunny, cloudy (but dry), or rainy. If it is sunny one day, then it is equally likely to be either cloudy or rainy the next day. If it is rainy or cloudy one day, then there is one chance in two that it will be the same the next day, and if it changes then it is equally likely to be either of the other two possibilities. In the long run, what proportion of days are sunny? What proportion are cloudy? **(8)**

(b) Consider a large population of individuals, each of whom possesses a particular pair of genes, of which each individual gene is classified as being of type α or type β. Assume that the proportions of individuals whose gene pairs are αα, ββ or αβ are respectively $p_0, q_0,$ and $r_0 \left(p_0 + q_0 + r_0 = 1\right)$. When two individuals mate, each contributes one of his or her genes, chosen at random, to the resultant offspring. Assuming that the mating occurs at random, in that each individual is equally likely to mate with any other individual, determine the proportions p, q, and r of individuals in the next generation whose genes are αα, ββ, or αβ respectively. **(12)**

(c) Consider a Poisson process with rate λ, and let us denote the time of the first event by *T1*. Further, for $n>1$, let T_n denote the elapsed time between the $(n-1)$st and the nth event. The sequence $\{T_n, n = 1, 2, \ldots,\}$ is called the sequence of inter-arrival times. Show that $T_n, n = 1, 2, \ldots,$ are independent identically distributed exponential random variables having mean $1/\lambda$. **(7)**

(d) Suppose that X_1 and X_2 are independent exponential random variables with respective means $1/\lambda_1$ and $1/\lambda_2$; what is $P\{X_1 < X_2\}$? **(8)**

8. (a) Customers arrive at a single-server station in accordance with a Poisson process with rate λ. All arrivals that find the server free immediately enter service. All service times are exponential distributed with rate μ. An arrival that finds the server busy will leave the system and roam around "in orbit" for an exponential time with rate θ at which time it will then return. If the server is busy when an orbiting customer returns, then that customer returns to orbit for another exponential time with rate θ before returning again. An arrival that finds the server busy and N other customers in orbit will depart and not return. That is, N is the maximum number of customers in orbit. **(4+3+3+3)**

(i) Define states.

(ii) Give the balance equations.

In terms of the solution of the balance equations, find

(iii) the proportion of all customers that are eventually served;

(iv) the average time that a served customer spends waiting in orbit.

Contd P/4

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Contd... Q. No. 8

(b) Consider a two-server system in which customers arrive at a Poisson rate λ at server 1. After being served by server 1 they then join the queue in front of server 2. We suppose there is infinite waiting space at both servers. Each server serves one customer at a time with server i taking an exponential time with rate μ_i for a service, $i = 1, 2$. Such a system is called a tandem or sequential system. For the tandem queuing system, compute **(12)**

(i) the average number of customers in the system,

(ii) the average time a customer spends in the system,

(c) Consider a system of two servers where customers from outside the system arrive at server 1 at a Poisson rate 4 and at server 2 at a Poisson rate 5. The service rates of 1 and 2 are, respectively, 8 and 10. A customer upon completion of service at server 1 is equally likely to go to server 2 or to leave the system (i.e., $P_{11} = 0, P_{12} = 1/2$), whereas a departure from server 2 will go 25 percent of the time to server 1 and will depart the system otherwise (i.e., $P_{21} = 1/4, P_{22} = 0$). Determine **(10)**

(i) the probability that there are n customers at server 1 and m customers at server 2.

(ii) the average number of customers in the system L, and

(iii) the average time a customer spends in the system W.

L-3/T-2/CSE **Date : 27/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2014-2015

Sub : **CSE 313** (Operating Systems)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE** questions.

1. (a) Operating systems need to play roles: **(15)**

(i) Referee

(ii) Illusionist

(iii) Glue

Identify the roles of operating systems for the following three tasks.

(i) Operating systems set up boundaries to "prevent bugs and malicious users and applications from affecting other users and their applications". However, "operating system must also allow those boundaries to be crossed in carefully controlled ways" so that various programs can effectively communicate with one another.

(ii) "Most operating systems also provide a standard way for applications to pass messages and to share memory."

(iii) Operating systems maintain virtual memory "to compensate for shortages of physical memory by temporarily transferring pages of data from random access memory (RAM) to disk storage."

(b) Suppose a computer system and all of its applications were completely bug free. Suppose further that everyone in the world were completely honest and trustworthy. In other words, we need not consider fault isolation. **(10)**

(i) How should an operating system allocate time on the processor? Should it give the entire processor to each application until it no longer needs it?

(ii) How should the operating system allocate its disk space? Should the first user to ask acquire all of the free spaces?

(c) "A central role of operating is protection – the isolation of potentially misbehaving applications and users so that they do not corrupt other applications or the operating system itself." Protection is essential to achieve the following goals of operating systems: **(10)**

(i) Reliability

(ii) Security

(iii) Privacy

(iv) Fairness

Contd P/2

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Contd ... Q. No. 1(c)

Identify the goals of operating systems for the following two tasks:

(i) "An operating system must bullet proof itself to operate correctly regardless of what an application or user might do."

(ii) A smartphone operating system must ensure a third-party app could not access user's contact list without the user's consent.

2. (a) One of the hardware supports that operating system kernel needs is **Privileged Instructions** to protect applications and users from one another. Which of the following three instructions do you think are privileged? **(10)**

(i) "Adding two registers together and storing the result in a third register"

(ii) "Setting up a page table for a process"

(iii) "Put CPU in idle state using halt"

(b) Operating systems implement "dual-mode operation, represented by a single bit in the processor status register that signifies the current mode of the processor. In user mode, the processor checks each instruction before executing it to verify that it is permitted to be performed by that process. In kernel mode, the operating system executes with protection checks turned off." However, there is also another need of "safely transition from executing a user process to execute the kernel, and vice versa." These two transitions are known as "User to Kernel Mode Transfer" and "Kernel to User Mode Transfer" respectively. A special type of kernel to user mode transfer is "Upcall". From the following scenarios you need to identify the examples of user to kernel mode transfer, kernel to user mode transfer, and upcalls. **(16)**

i. **Resume after an interrupt**: When handling the request is finished, "the execution of the interrupted process is resumed by restoring its program counter."

ii. **Processor Exception**: "A processor exception is a hardware event caused by user program behavior after which the hardware finishes all previous instructions, saves the current execution state, and starts running at a specially designated exception handler."

iii. **New process**: To start a new process, its program is copied into memory, the program counter is set to the first instruction, the stack pointer is set to the top of the stack, and then the process is started.

iv. **Resource allocation**: "Operating systems allocate resources - deciding which users and processes should get how much CPU time, how much memory, and so forth. In turn, many applications are resource adaptive – able to optimize their behavior to differing amounts of CPU time or memory. An example is Java garbage collection.

Contd P/3

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Contd ... Q. No. 2(b)

Within limits, a Java process can adapt to different amounts of available memory by changing the frequency with which it runs its garbage collector.

The more memory, the less time Java needs to run its collector, speeding execution. For this, the operating system must inform the process when its allocation changes, e. g., because some other processes need more or less memory."

(c) What is saved/restored on a process context switch if memory is managed using- **(9)**

(i) virtually addressed base and bounds

(ii) segmentation

(iii) paging

3. (a) Why do you think process management approach implemented in Windows is "simple in theory, however, complex in practice"? Explain. **(10)**

(b) Consider the following program: **(10)**

```
int main(int argc, char *argv[]){
    int child = fork();
    int x = 10;
    if(child){
        x += 10;
    } else {
        child = fork();
        x += 10;
        if(child == 0) {
            x += 10;
        }
    }
    return 0;
}
```

How many different copies of the variable **x** are there? What are their values when their processes finish?

(c) Illustrate virtually and physically addressed caches in a single block diagram. Suppose you have only one cache available. What addressing scheme would you use in this cache, virtually or physically addressed? Justify your answer. **(15)**

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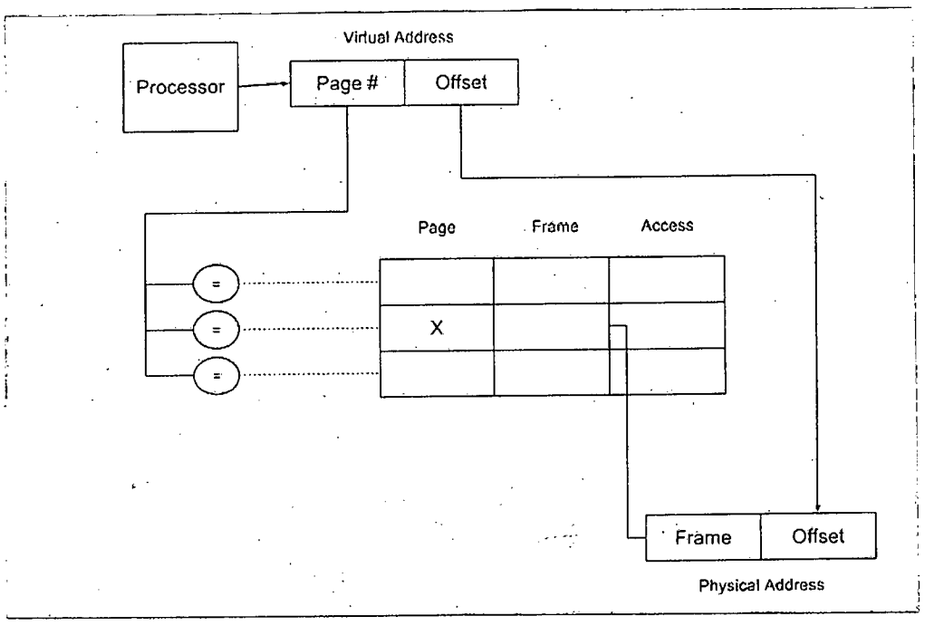
4. (a) Update the following translation lookaside buffer so that it can support multiple processes along with context switch. **(10)**



(b) Consider the following cache usage scenarios. Which replacement policies should we use for each usage scenario? **(8)**

	Random	FIFO	LRU	LFU	MRU
Web server cache					
Browser DNS cache					
Email client inbox					
Looping memory references					

(c) Illustrate the Cache Write Concept with block diagram. **(7)**

(d) For each of the following statement, indicate whether the statement is true or false, and also explain why. **(10)**

(i) "A virtual memory system that uses paging is vulnerable to internal fragmentation."

(ii) "A direct mapped cache can sometimes have a higher hit rate than a fully associative cache with FIFO replacement policy."

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE** questions.

5. (a) Describe the four stages of growth an NTFS file can go through with appropriate figures. **(15)**

(b) Discuss the characteristics of FFS multi-level index structure. **(10)**

Contd P/5

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Contd ... Q. No. 5

(c) Draw the software layers that provide file system abstraction. What is the role of device drivers? **(5+5=10)**

6. (a) State and compare the locality heuristics of FAT, FFS, and NTFS file systems. **(15)**

   (b) Compare the efficiency of random access in FAT and FFS file systems. **(10)**

   (c) Provide an example where application libraries wrap system calls to add an additional functionality. **(10)**

7. (a) Consider the program on the left side and one possible output on the right side of the following figure. **(6×3=18)**

```
#include <stdio.h>
#include "thread.h"

static void go(int n);

#define NTHREADS 10
static thread_t threads[NTHREADS];

int main(int argc, char **argv) {
    int i;
    long exitValue;

    for (i = 0; i < NTHREADS; i++){
        thread_create(&(threads[i]), &go, i);
    }
    for (i = 0; i < NTHREADS; i++){
        exitValue = thread_join(threads[i]);
        printf("Thread %d returned with %ld\n",
                        i, exitValue);
    }
    printf("Main thread done.\n");
    return 0;
}

void go(int n) {
    printf("Hello from thread %d\n", n);
    thread_exit(100 + n);
    // Not reached
}
```

```
% ./threadHello
Hello from thread 0
Hello from thread 1
Thread 0 returned 100
Hello from thread 3
Hello from thread 4
Thread 1 returned 101
Hello from thread 5
Hello from thread 2
Hello from thread 6
Hello from thread 8
Hello from thread 7
Hello from thread 9
Thread 2 returned 102
Thread 3 returned 103
Thread 4 returned 104
Thread 5 returned 105
Thread 6 returned 106
Thread 7 returned 107
Thread 8 returned 108
Thread 9 returned 109
Main thread done.
```

Figure for Question 7(a)

Now answer the following questions.

(i) Why has the "Hello" message from thread 3 been printed before the "Hello" message from thread 2? Is it guaranteed that this sequence is always maintained?

(ii) Why has the "Thread returned" message from thread 3 been printed after the "Thread returned" message from thread 2? Is it guaranteed that this sequence is always maintained?

(iii) Why have the "Hello" message been merged with "Thread returned" messages?

(iv) What is the minimum and maximum number of threads that could exist when main thread prints "Thread returned" message?

(v) What is the minimum and maximum number of times that the thread 2 enters the READY state on a uniprocessor?

(vi) When **thread _join** returns for thread 3, what is the state of the main thread?

Contd P/6

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Contd ... Q. No. 5

(b) What are the problems with a buggy thread? **(5)**

(c) Briefly explain Safety and Liveness in the context of "Too much Milk" problem. **(6)**

(d) "P( ) and V( ) functions of semaphore are commutative but wait( ) and signal( ) functions of condition variable are not." – Briefly explain. **(6)**

8. (a) For implementing lock in multiprocessor, why are disabling interrupts not enough? What extra measure should be taken? **(4+2=6)**

(b) Show that the Dining Philosophers problem meets all the four conditions for deadlock. **(8)**

(c) Briefly describe the scenario where both First-In-Out (FIFO) and Shortest Job First (SJF) scheduling work better than Round Robin scheduling. Why is space sharing more efficient then time sharing gin case of scheduling parallel applications? **(7+3=10)**

(d) What is the "Cache Coherence Overhead" problem in scheduling sequential applications on multiprocessors? How can this problem be solved? **(7+4=11)**

L-3/T-2/CSE **Date : 01/08/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2014-2015

Sub : **CSE 317** (Numerical Methods)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Derive the high accuracy differentiation formula for the forward finite difference approximation of the first derivative. Estimate the first derivative of the function $f(x)=0.1x^4+0.25x^3-0.55x^2+0.4x+3$ at $x=0.5$ by (i) the high accuracy forward difference formula using the step-size of 0.5 (ii) Richardson extrapolation method with the high accuracy forward difference formula using the step-sizes of 0.5 and 1.0. **(18)**

   (b) What is the major distinction between the Newton-Coates formulas and the Gauss quadrature formulas for numerical integration? Show how you can derive the weighted factors of the Simpson's 1/3 rule for numerical integration. In addition, show that the first level of error elimination in Romberg integration results in the Simpson's 1/3 rule. **(17)**

2. (a) Numerically integrate the function $f(t)=t\sin t$ using (i) the trapezoidal rule (ii) Simpson's 3/8 rule from the lower limit 0 to the upper limit π. **(10)**

   (b) Briefly explain the need for linearization of non-linear relationships with illustrative examples from the exponential and the power equation models. **(10)**

   (c) Use the least-squares regression to fit a straight line to the following data: **(15)**

x	1	5	10	12
y	4	6	8	7

   Also, determine the standard error of the estimate and the correlation coefficient. Comment on the merit of the fitted model.

3. (a) What is a slope field? Construct a slope field for the grid points between the origin and (2,2) for graphically solving the differential equation $dy/dx = x + y$ with the initial condition that $y = 1$ and $x = 0$. Use the step size 1.0 for both the x-axis and the y-axis. What is the value of y at $x = 1$? Also, solve the same initial value problem using the Taylor series method considering the terms up to x^2. **(14)**

Contd P/2

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Contd... Q. No. 3

(b) Find the sequence of approximations of y using the Picard's method for the initial value problem: **(11)**

$dy/dx = 2x(1+y)$ and $y = 0$ at $x = 0$. What is the n-th approximation?

(c) By means of an illustrative example, explain the difference between local and global errors for solving a differential equation with the Euler method. What are the estimated local and global errors of the midpoint method? **(10)**

4. (a) Fit a sinusoid for the following data from a periodic function: **(14)**

x	0	2	4	6	8
y	8	4	8	1	8

Use your fit to determine the amplitude and the phase shift.

(b) What is the major distinction between the Fourier series and the Fourier Transform? **(21)**

How can you find the Discrete Fourier Transform (DFT) of a given set of points? For the sequence {9, 7, 5, 7}, determine the DFT and the power spectrum for the fundamental frequency and the second harmonic.

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Discuss the engineering problem-solving process using a flow chart. What is the main difference between a numerical method and a classical method in solving an engineering problem? **(7+2)**

(b) Determine the real root of $f(x) = -26 + 85x - 91x^2 + 44x^3 - 8x^4 + x^5$ using the bisection method. Employ initial guesses of $x_l = 0.5$ and $x_u = 1.0$. Iterate the process until the approximate error falls below a stopping criterion of $\varepsilon_s = 10\%$. Note that you must show the detail calculation of the first iteration. **(13)**

(c) Perform the same computation as in (b) but use the false-position method and $\varepsilon_s = 0.2\%$. **(13)**

6. (a) What are the main problems of graphical methods and Cramer's rule in finding the root of transcendental equations? **(5)**

Contd P/3

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Contd... Q. No. 6

(b) Determine the highest real root of $f(x)=2x^3-11.7x^2+17.7x-5$ using the Fixed-point iteration method with x_0 = 3 (for five iterations). Explain your results with respect to convergence of the method. Note that you must show the detail calculation of the first iteration. **(15)**

(c) Perform the same computation as in (b) but use the Modified secant method (three iteration, x_0 = 3, δ = 0.01). Compute the approximate percent relative errors for your solutions. **(15)**

7. (a) Prove that the Newton-Raphson method has quadratic convergence property. **(8)**

(b) Use Gauss-Jordan elimination to solve: **(15)**

$$2x_1+x_2-x_3=1$$
$$5x_1+2x_2+2x_3=-4$$
$$3x_1+x_2+x_3=5$$

Do not employ pivoting. Check your answers by substituting them into the original equations.

(c) Solve the following system of equations by LU decomposition without pivoting **(12)**

$$x_1+7x_2-4x_3=-51$$
$$4x_1-4x_2+9x_3=62$$
$$12x_1-x_2+3x_3=8$$

8. (a) What are the problems associated with the Newton-Raphson method? Discuss how the Secant method solves some of them. **(10)**

(b) Use Newton's interpolating polynomial to determine y at x = 3.5 to the best possible accuracy. **(15)**

x	0	1	2.5	3	4.5	5	6
y	2	5.4375	7.3516	7.5625	8.4453	9.1875	12

(c) How does the Gauss-Jordan elimination method overcome some of the problems of the Gauss elimination method in solving a system of linear equations? Show that an iterative method converges to a near optimal value if you allow an infinite number of iterations. **(4+6)**
