L-3/T-2/CSE **Date : 17/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2013-2014

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) Compare circuit switching, virtual circuit and datagram with respect to signaling overhead, utilization and speed. **(12)**

   (b) Why is distance vector routing algorithm not suitable for large networks? Explain. **(10)**

   (c) Flooding is not practical for most applications but it does have uses in military applications. What may be the reasons for such applications? **(10)**

   (d) Consider the subnet as shown below where distance vector routing is used and following vectors have just come to router C: from B(5, 0, 8, 12, 6, 2); from D(16, 12, 6, 0, 9, 10); and from E(7, 6, 3, 9, 0, 4). The measured delays to B, D and E are 6, 3 and 5, respectively. What is C's new routing table? **(14⅔)**

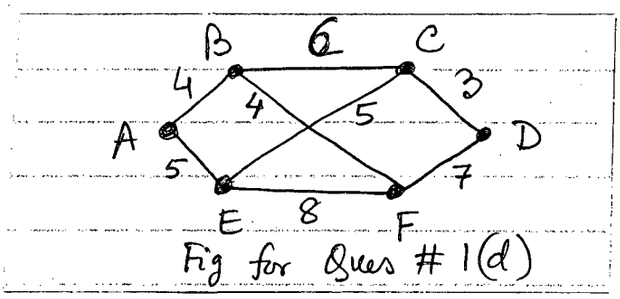

Fig for Ques # 1(d)

2. (a) What is the role of Sequence number in each packet while flooding link state packets (by routers)? What can happen if the sequence number gets corrupted? What can be a possible solution? **(12)**

   (b) Explain reverse path forwarding broadcast algorithm with necessary diagram. **(12)**

   (c) Give an argument why leaky bucket algorithm should allow just one packet per tick, independent of how large the packet is. **(10⅔)**

   (d) Consider a flow having a maximum packet size of 1000 bytes, a token bucket rate of 10 million bytes/sec, a token bucket size of 1 million bytes and a maximum transmission rate of 50 million bytes/sec. How long can a burst at maximum speed last? **(12)**

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3. (a) Draw the state transition diagram for TCP connection establishment and release. You must show normal and abnormal scenarios. **(14)**

(b) What are the issues related to a fixed RTT timer of TCP? How is it made dynamic? Which one is the main factor that influences the dynamism of RTT? Explain with equations. **(12)**

(c) What is the main purpose of persistence timer in TCP? What problem does it try to solve? **(7)**

(d) Explain silly window syndrome with an example case (when it occurs). Mention one solution to this problem. **(7)**

(e) Draw the UDP header and explain its fields. Why is there no "ACK" or "Sequence number" field? **(6⅔)**

4. (a) How does RPC work? Explain with necessary block diagram. **(10)**

(b) What are the factors considered by a TCP sender to control congestion in the network? What is the purpose of congestion window? Explain briefly. **(10)**

(c) What does authoritative record mean in domain name system? Give example. **(6⅔)**

(d) Explain different components involved in email communication using necessary topology diagram. **(12)**

(e) Distinguish between IMAP and POP3. **(8)**

SECTION – B

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

5. (a) A straightforward way to use DES for encrypting a long piece of plaintext is to break the plaintext into consecutive 8-byte (64-bit) blocks and encrypt them one after another with the same key. However, this straightforward method can easily come under the threat of simple copy-paste like attack by an intruder. To overcome this, each plaintext block can be XOR-ed with the previous ciphertext block before being encrypted. However, this method also exhibits the limitation of requiring an entire 64-bit block to arrive before decryption can begin. This requirement can be completely undersirable for interactive applications, where byte-by-byte encryption is required. **(23⅔)**

Now your first task is to present and elaborate with necessary figures how you can perform the byte-by-byte encryption.

Second, you need to figure out whether your solution would exhibit a limitation of messing up 64 bits even in case of having only 1-bit transmission error. If you do not find so, you need to elaborate how your solution can overcome this limitation. If you find so, you need to present another mechanism for overcoming the limitation.

Contd P/3

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Contd... Q. No. 5

(b) A firm is using public-key cryptography for ensuring protection of its data being transmitted over a network. The firm starts thinking of enabling a mechanism of authentication in addition to the already-existing secrecy of data. To do so, it starts analyzing all the possibilities. **(23)**

One of the security experts of the firm mentions that there is no other way but to use shared-key authentication for achieving the goal. He mentions several methods available in this regard such as Two-way authentication, authentication using HMACs, Needham-Schroeder authentication, Otway-Rees authentication, etc.

Do you agree with the expert that authentication will not be possible using a public key. If you agree, then explain the reasons behind it. If you disagree, then elaborate a mechanism by which you can enable authentication using public-key cryptography.

6. (a) In a WDMA protocol, each station is equipped with two transmitters and two receivers as follows: one fixed-wavelength receiver for listening to own control channel, one tunable receiver to select a data transmitted to listen to, one fixed-wavelength transmitter to output data frames, and one tunable transmitter to send one other stations' control channels. Now, you need to judge whether none, or anyone, or both of the following statements are true for the protocol– **(23⅔)**

   (i) Neither control nor data signal transmitted simultaneously by multiple transmitter stations to the same receiver station can be successfully transmitted.

   (ii) Both control and data signals transmitted simultaneously by multiple transmitter stations to the same receiver station can be successfully transmitted.

   You need to make your judgment with proper reasoning and necessary figures.

   (b) A Hawaiian company began with a network having only a coupe of machines. It started the network operation with Slotted ALOHA. After a few years, the company grew over tens of computers. Then, it realized that it cannot go any more with Slotted ALOHA. It started thinking of throwing away Slotted ALOHA altogether and enabling a Collision-free protocol in place of the Slotted ALOHA. **(23)**

   Do you think that throwing away Slotted ALOHA altogether was the best approach to be adopted? If you think so, then explain reasons behind it. If you do not think so, then mention what could be a better option and why.

7. (a) You are given a job of connecting several LANs. Which of the following device(s) you will use to do so - hub, switch, bridge, and router. Elaborate reason(s) behind you choice and the mechanism of using the chosen device. **(23⅔)**

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Contd... Q. No. 7

(b) A network designer designs a system for mobile communication with 1 MHz band available for 100 stations each having 10 KHz. Keeping 1 bit per hertz, he comes up with a speed of 10 kbps in this case. After doing so, he concludes that a speed higher than 10 kbps is not achievable here with any of the contemporary mobile communication systems. **(23)**

Do you think that the conclusion drawn by the designer is a correct one considering only the contemporary systems? If you think so, you need to justify it. If you do not think so, you need to elaborate one existing system that can refute the conclusion through going beyond the speed of 10 kbps.

8. (a) LED offers long lifetime, less temperature sensitivity, and low-cost solution for light sources in fiber optic networks compared to that of laser. However, laser still gets preference over LED in some cases. You need to point out the cases where laser gets the preference and you need to mention reasons behind getting the preference. **(13⅔)**

(b) Draw a passive star connection in a fiber optics network. **(10)**

(c) Can we use Hamming code for error correction in a system where burst errors of k length may arrive? If yes, then how can we do that? If not, then which property of Hamming code inhibits the usage and how does the property inhibits the usage? **(23)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2013-2014

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) A certain letter is equally likely to be in any one of three different files. Let, α_i be the probability that you will find the letter upon making a quick examination of file i, if the letter is, in fact, in file i, $i = 1,2,3$. Given $\alpha_1 = 1/2$, $\alpha_2 = 1/3$, $\alpha_3 = 1/4$. Suppose you look into file 1 and do not find the letter after quick examination. What is the probability that the letter is in file 1? **(10)**

(b) An airline knows that 5 percent of the people making reservations on a certain flight will not show up. Consequently, their policy is to sell 52 tickets for a flight that can hold only 50 passengers. What is the probability that there will be a seat available for every passenger who shows up? **(10)**

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

2. (a) At a party n men take off their hats. The hats are then mixed up and each man randomly selects one. We say that a match occurs if a man selects his own hat. What is the probability of no matches? What is the probability of exactly k matches? **(8+5)**

(b) A miner is trapped in a mine containing three doors. The first door leads to a tunnel that takes him to safety after two hours of travel. The second door leads to a tunnel that returns him to the mine after three hours of travel. The third door leads to a tunnel that returns him to his mine after five hours. Assuming that the miner is at all times equally likely to choose any one of the doors, what is the expected length of time until the miner reaches safety? **(10)**

(c) A computer receives requests for elements stored in its memory. Consider n elements $e_1, e_2, \ldots, e_n$ are initially arranged in some ordered list. At each unit of time of request is made for one of these elements — e_i being requested, independently of the past, with probability P_i. After being requested, the element is then moved to the front of the list. That is, for instance, if the present ordering is e_1, e_2, e_3, e_4 and e_3 is requested, then the next ordering is e_3, e_1, e_2, e_4. Determine the expected position of the element requested after this process has been in operation for a long time. **(12)**

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3. (a) An organization has N employees where N is a large number. Each employee has one of three possible job classifications and changes classifications (independently) according to a Markov chain with transition probabilities. **(8)**

$$\begin{bmatrix} 0.7 & 0.2 & 0.1 \\ 0.2 & 0.6 & 0.2 \\ 0.1 & 0.4 & 0.5 \end{bmatrix}$$

In the long run, what percentages of employees are in each classification?

(b) Consider a gambler who at each play of the game has probability p of winning one unit and probability $q = 1-p$ of losing one unit. Assuming that successive plays of the game are independent, what is the probability that, starting with i units, the gambler's fortune will reach N before reaching 0? **(12)**

(c) Define counting process and illustrate its properties. When do we regard a counting process as a Poisson process? **(4+3)**

(d) Suppose that people immigrate into a territory at a Poisson rate $\lambda = 1$ per day. **(4+4)**

(i) What is the expected time until the tenth immigrant arrives?

(ii) What is the probability that the elapsed time between the tenth and the eleventh arrival exceeds two days?

4. (a) Consider a shoe shop consisting of two chairs. Suppose that an entering customer first will go to chair 1. When his work is completed in chair 1, he will go either to chair 2 if that chair is empty or else wait in chair 1 until chair 2 becomes empty. Suppose that a potential customer will enter this shop as long as chair 1 is empty. (Thus, for instance, a potential customer might enter even if there is a customer in chair 2.) Suppose that potential customers arrive in accordance with a Poisson process at rate λ, and that the service times for the two chairs are independent and have respective exponential rates of μ_1 and μ_2. **(7+2+2+2)**

(i) Draw a state diagram of the system and write down balance equations for each state.

(ii) What proportion of potential customers enters the system?

(iii) What is the mean number of customers in the system?

(iv) What is the average amount of time that an entering customer spends in they system?

(b) Suppose that customers arrive at a single-server service station in accordance with a Poisson process having rate λ. That is, the times between successive arrivals are independent exponential random variables having mean $1/\lambda$. Each customer, upon

Contd P/3

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Contd... Q. No. 4(b)

arrival, goes directly into service if the server is free and, if not, the customer joins the queue. When the server finishes serving a customer, the customer leaves the system, and the next customer in line, if there is any, enters service. The successive service times are assumed to be independent exponential random variables having mean $1/\mu$. This system is called the *M/M/1* queue. For the *M/M/1* queuing system, compute **(12)**

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

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

(iii) the average number of customers in the queue and

(iv) the average time a customer spends in the queue.

(c) Consider a network of three stations with a single server at each station. Customers arrive at stations 1, 2, 3 in accordance with Poisson processes having respective rates 5, 10, and 15. The service times at the three stations are exponential with respective rates 10, 50, and 100. A customer completing service at station 1 is equally likely to (i) go to station 2, (ii) go to station 3, or (iii) leave the system. A customer departing service at station 2 always goes to station 3. A departure from service at station 3 is equally likely to either go to station 2 or leave the system. **(10)**

(i) What is the average number of customers in the system (consisting of all three stations)?

(ii) What is the average time a customer spends in the system?

SECTION – B

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

5. (a) Use repertoire method to solve the following general four-parameter recurrence: **(10)**

$$R(0)=\alpha;$$
$$R(n)=R(n-1)+\beta n^2+\gamma n+\delta, \qquad \text{for } n>0$$

(b) Prove that, each fraction that appears in the Stern-Brocot tree is in lowest terms. **(8)**

(c) Prove that, $E_2(n!)=n-V_2(n)$, for $n>0$. Here, $E_2(n!)$ is the exponent of 2 in the unique prime factorization of $n!$ and $V_2(n)$ is the number of 1's in the binary representation of n. **(9)**

(d) Alice writes a radix 4 number in a paper and sends it to Bob. But Bob thinks that the received number is a decimal number. For example, if Alice wants to send $(57)_{10}$, he writes down 321 (which is the radix 4 representation of $(57)_{10}$) and sends it to Bob. Bob thinks the number is $(321)_{10}$. Suppose F is the function that converts Alice's number to Bob's number. For example, $F((57)_{10})=(321)_{10}$. Provide a recursive definition of F. **(8)**

Contd P/4

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6. (a) Let Z_n denote the maximum number of regions that can be created by placing n zigs in a plane. Determine the closed form of Z_n with appropriate explanation. **(9)**

(b) Prove that, $\ln n < H_n < \ln n + 1$, for $n > 1$, where $H_n = \sum_{k=1}^{n} \frac{1}{k}$. **(9)**

(c) Let *J(n)* be the number of the survivor among n people in the Josephus problem. There are infinitely many n's for which $J(n) = n/2$. Write down the first three such numbers. **(7)**

(d) In how many ways, can you select five non-consecutive integers from the set $\{1,2,3,\cdots,20\}$? **(10)**

7. (a) Use generating functions to prove that, $\sum_{k=0}^{n} k^2 = \frac{1}{6} n(n+1)(2n+1)$. **(12)**

(b) State and explain the recurrence relation for "*n subset k*". There are m^n functions from a set of n elements into a set of m elements. How many of them range over exactly k different function values? **(6+6)**

(c) Consider the following two problems. The first problem is to find the number of rooted binary trees consisting of n nodes. The second problem is to find the number of valid parenthesizations formed by n pair of brackets. **(6+5)**

(i) There exists a bijection between the above two problems. Describe a rule of converting a rooted binary tree into a unique valid parenthesization and vice versa.

(ii) There are five rooted binary trees with three nodes and five valid parenthesizations can be formed using three pair of brackets. For all five valid parenthesization, draw the corresponding rooted binary tree according to the rule of conversion you mentioned.

8. (a) How many integers n are there such that, $\lfloor \sqrt[3]{n} \rfloor \backslash n$ and $1 \le n \le 2000$. **(13)**

(b) State Vandermonde's convolution formula. Give a combinatorial proof of Vandermonde's convolution formula for non-negative integers. Then use polynomial argument to prove the general case. **(2+5+5)**

(c) Give a combinatorial proof that, the alternating sum of the n^{th} row of Pascal's triangle is zero. In other words, $\sum_{k=0}^{n} (-1)^k \binom{n}{k} = 0$, for $n > 0$. **(10)**

L-3/T-2/CSE **Date : 27/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2013-2014

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

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) Suppose the execution of a particular process requires reference to five distinct pages. The page reference sequence of the program is: **(15)**

2, 3, 2, 1, 5, 2, 4, 5, 3, 2 5, 2

which means that the first page referenced is 2, the second page referenced is 3, and so on. Assume that the physical memory contains three page frames and all the page frames are initially empty. Depict the behavior of each of the following page replacement algorithms for this process.

(i) Optimal page replacement algorithm

(ii) First-In First-Out (FIFO) page replacement algorithm

(iii) Least Recently Used (LRU) page replacement algorithm

You must show the state of physical memory after each page reference and calculate total page hit for each algorithm.

(b) Consider a computer system with 64 bits virtual address space. **(10)**

(i) Calculate the memory required to store a simple single-level page table for a single process given that

- Page size = 4 KB
- Physical memory size = 4 GB
- Each page table entry stores 12 bits of information in addition to 52 bits physical frame number

(ii) Calculate the memory required to store a single global inverted page table for all process given than

- Page size = 4 KB
- Physical memory size = 4 GB
- Process ID consists of 16 bits
- Each page table entry stores 12 bits of information in addition to virtual page number and process ID

(c) Suppose you are using paging technique for implementing virtual memory with 32 bit address space and 4 KB page size. You have decided to keep the entire page table for each process in main memory. As a result, you have to allocate a huge amount of memory for keeping the page table. Explain with necessary figures how you can solve this problem. You must prove the space efficiency of your technique. **(10)**

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2. (a) Suppose two processes P1 and P2 are running concurrently in a single processor system. The system contains two dedicated resources: one printer and one DVD-ROM. These resources can be used by only one process at a time. Both P1 and P2 has 600 instructions. P1 requests the DVD-ROM at 200th instruction and the printer at 400th instruction. P1 releases the DVD-ROM and printer at 300th and 500th instruction respectively. P2 requests the printer at 200th instruction and the DVD-ROM at 300th instruction. P2 releases the printer and DVD-ROM at 400th and 500th instruction respectively. **(10)**

Draw a diagram where each point depicts a joint state of the two processes where the horizontal axis represents the number of instructions executed by P1 and the vertical axis represents the number of instructions executed by P2. You must mark the regions where entry is restricted by the mutual exclusion rule.

(b) The following figure shows the state of a system consisting of four processes and three resources. The total amount of resources R1, R2, and R3 are 9, 3, and 6 units, respectively. Here, **R** is the total existing resource vector, **V** is available resource vector, and **A** is the current allocation matrix. The Claim matrix **C** shows the maximum requirement of each process for each resource. **(10)**

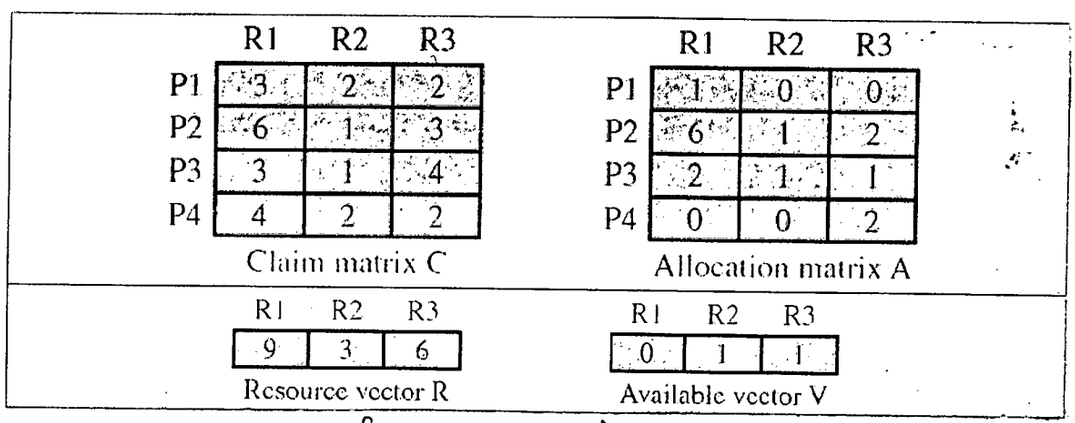

Figure for Q. No. 2(b)

(i) "The above system is in safe state"– Do you agree with this statement?

(ii) Provide proof for your answer?

(c) A particular CPU scheduling algorithm is implemented as follows: **(15)**

The ready queue of processes is treated as a FIFO queue. New processes are added to the tail of the ready queue as soon as they arrive. The scheduler removes a process from the head of the ready queue, sets a timer to interrupt after Q seconds, and gives control of the CPU to the process for execution.

One of two things will then happen:

(i) The currently running process may have a CPU burst of less than Q. In this case, the process itself will release the CPU voluntarily.

Contd P/3

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Contd... Q. No. 2(c)

(ii) If the CPU burst of the currently running process is longer than Q, the timer will go off and will cause an interrupt to the operating system. The process will be added at the tail of the ready queue.

The scheduler will then remove another process from the head of the ready queue and proceed in the similar fashion.

Apply the above described algorithm for scheduling the workload given in the following table and illustrate the resulting schedule using Gantt chart for each of the cases:

(i) Q = 1

(ii) Q = 2

(iii) Q = 4

Assume that the process switching time is 0 second.

Process	Arrival Time (sec)	CPU Burst Time (sec)
A	0	3
B	1.8	6
C	3.2	4
D	5.6	5
E	7.9	2

Table for Q. No. 2(c)

3. (a) Consider the code written in C shown in the following figure. Here **fork()** is an UNIX system call that creates a child process identical to the parent. Executing this code will generate a process tree. Each of the created process will have its own copy of variable **i.** Your task is to draw this process tree. At each node of the tree you have to mention the starting value of **i** for the corresponding process. The root node is shown in the next figure. Draw the complete process tree appropriately. **(10)**

```
#include <stdio.h>
#include <unistd.h>
int i = 0;
int main()
{
    for (; i < 3 ; i++)
        fork();
    return 0;
}
```

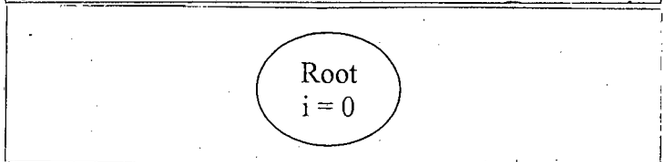

Figure for Q. No. 3 (a)

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Contd... Q. No. 3

(b) The process state transition diagram for a uniprocessor system is shown in the following figure. **(15)**

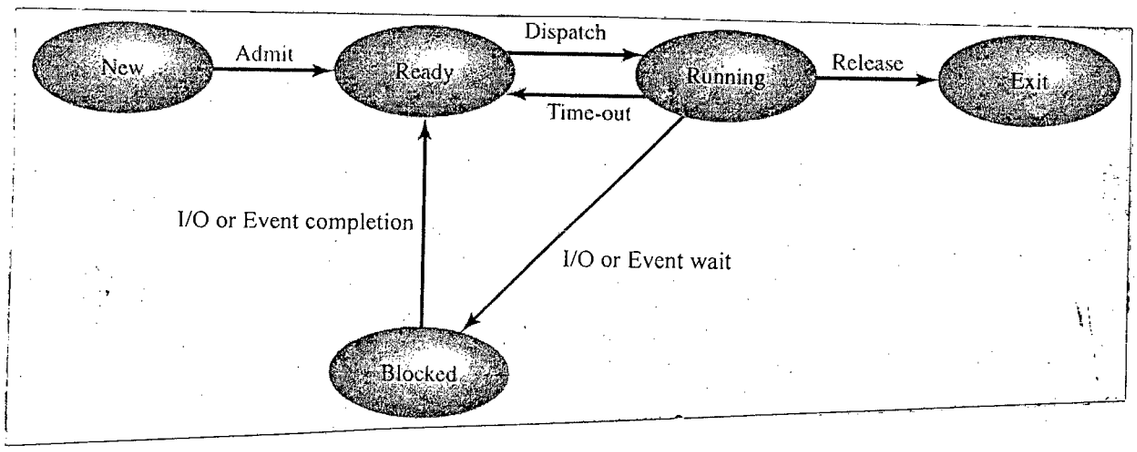

Figure for Q. No. 3(b)

Assume that there are only 5 processes named P1, P2, P3, P4 and P5 in the system. At time 0, each of the processes is in **Ready** state. The scheduler operates in round-robin fashion.

All events except dispatch that occur from time 5 to time 48 listed below:

- At time 5: P1 executes a command to read from disk.
- At time 15: P3's time slice expires.
- At time 18: P4 executes a command to write to disk.
- At time 20: P2 executes a command to read from disk.
- At time 23: P5 goes to sleep for 7 unit of time.
- At time 24: P3 executes a command to write to disk.
- At time 30: P5 wakes up from sleep.
- At time 33: An interrupt occurs from disk unit 2: P2's read is complete.
- At time 36: An interrupt occurs from disk unit 3: P1's read is complete.
- At time 38: P5 terminates.
- At time 40: An interrupt occurs from disk: P3's write is complete.
- At time 48: An interrupt occurs from disk: P4's write is complete.

Now infer the state of each process using the available information for each of the cases:

(i) At time 22

(ii) At time 37

(iii) At time 47

(c) For each of the page replacement algorithms listed below, mention the tasks which should be performed on each clock interrupt: **(10)**

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Contd... Q. No. 3(c)

(i) First-In First-Out (FIFO): Replaces the oldest page

(ii) Second Chance: A simple modification to FIFO

(iii) Not Frequency Used (NFU): A crude approximation to LRU

(iv) Aging: A much better approximation to LRU

(v) WSClock: Based on working set information.

4. (a) Assume that a finite number of resources of a single resource type must be managed. Processes may ask for a number of these resources and will return them once finished. As an example, many commercial software packages provide a given number of licenses, indicating the number of applications that may run concurrently. When the application is started, the license count is decremented. When the application is terminated, the license count is incremented. If all licenses are in use, requests to start the application are denied. Such requests will only be granted when an existing license holder terminates the application and a license is returned. **(15)**

The following program segment is used to manage a finite number of instances of an available resource. The maximum number of resources and the number of available resources are declared as follows:

```
1.  #define MAX_RESOURCES 5
2.  int available_resources = MAX_RESOURCES;
```

When a process wishes to obtain a number of resources, it invokes the **`decrease_count()`** function:

```
3.  /* decrease available_resources by count resources */
4.  /* return 0 if sufficient resources available, */
5.  /* otherwise return -1 */
6.  int decrease_count(int count) {
7.        if (available_resources < count)
8.              return -1;
9.        else {
10.             available_resources -= count;
11.             return 0;
12.       }
13. }
```

When a process wants to return a number of resources, it calls the **`increase_count()`** function:

```
14. /* increase available_resources by count */
15. void increase_count(int count) {
16.       available_resources += count;
17. }
```

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Contd... Q. No. 4(a)

The preceding program segment produces race condition.

(i) Identify the data involved in the race condition.

(ii) Mention the line number (or numbers) of the statement (or statements) in the above code which is (or are) responsible for the race condition.

(iii) Using a single binary semaphore, fix the race condition. You must rewrite the complete code. Make sure that your fixed version of **decrease_count()** returns 0 if sufficient resources are available and -1 otherwise.

(b) Te **decrease_count()** function in the question 4(a) currently returns 0 if sufficient resources are available and -1 otherwise. This leads to busy waiting for a process that wishes to obtain a number of resources: **(10)**

```
while (decrease count(count)== -1);
```

Implement a monitor named **resource_manager** which contains necessary data variables, condition variables and two functions named **void decrease_count(int count), void increase_count(int count)** such that **decrease_count()** function suspends the calling process until sufficient resources are available. This will allow a process to invoke **decrease_count()** by simply calling.

```
Resource_manager.decrease_count(count);
```

The calling process will return from this function call only when sufficient resources are available. You must maximize the degree of parallelism.

(c) Any facility or capability that is to provide support for mutual exclusion should meet the following requirements: **(10)**

(i) No two processes simultaneously in critical region

(ii) No assumptions made about speeds or numbers of CPUs

(iii) No process running outside its critical region may block another process

(iv) No process must wait forever to enter its critical region

A software solution to the mutual exclusion problem for two processes (Process 0 and Process 1) is proposed in Figure for Q. No. 4(c). Here the program fragments are written in C. The integer variable **truth**, initially 0, is shared by Process 0 and Process 1.

Process 0	Process 1

`while (TRUE) {`
`  while (turn != 0);`
`  critical_region( );`
`  turn = 0;`
`  noncritical_region( );`
`}`
	`while (TRUE) {`
	`  while (turn != 1);`
	`  critical_region( );`
	`  turn = 1;`
	`  noncritical_region( );`
	`}`

Figure for Q. No. 4(c)

Mention the conditions violated by this solution with proper explanation.

Contd P/7

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SECTION – B

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

5. (a) Give a brief description of the followings: **(2½+2½=5)**

   (i) GNU/Linux OS

   (ii) Linux Distributions

   (b) Describe a scenario when two entries of a user file descriptor table may point to the same entry of the file table in UNIX. **(3)**

   (c) "While allocating an in-core inode in UNIX, the kernel either returns a locked in-core inode or returns an error" — Justify this statement using illustrative examples. **(6)**

   (d) Give a comparison of the free inode list and the free block list of the super block of a file system in UNIX. **(4)**

   (e) Answer the following question with respect to UNIX System V. **(2+3+2+4=11)**

   (i) Describe the inode table of content structure.

   (ii) If the logical block size of the file system is 1024 bytes and 4-byte integer is needed for data block addressing, what is the maximum byte capacity of a file?

   (iii) If the file size field in the inode is 8 bytes, what is the maximum file size of the operating system?

   (iv) Where can you find the 360,000 byte offset of a file in the system?

   (f) Describe the if-else statements in the given algorithm for releasing a buffer in UNIX using illustrative examples. **(6)**

```
algorithm brelse
input:  locked buffer
output: none
{
        wakeup all procs: event, waiting for any buffer to become free;
        wakeup all procs: event, waiting for this buffer to become free;
        raise processor execution level to block interrupts;
        if (buffer contents valid and buffer not old)
                enqueue buffer at end of free list
        else
                enqueue buffer at beginning of free list
        lower processor execution level to allow interrupts;
        unlock(buffer);
}
```

Algorithm for Question 5 (f)

Contd P/8

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6. (a) "Linux is an example of UNIX operating system" — Justify this statement showing necessary comparisons. **(7)**

(b) Why the logged operations in journaling file systems must be idempotent? Explain with an illustrative example. **(5½)**

(c) Describe in-line and in-a-heap directory structure stating the advantages and disadvantages of each method using illustrative examples. **(4+4=8)**

(d) What happens to the different regions of a process when the **fork** system call is invoked by a process? Explain with respect to related UNIX kernel data structure. Use the illustrative figures are recommended. **(7)**

(e) Give a brief description of the followings: **(2½×3=7½)**

(i) Zombie state of a process in UNIX

(ii) Dynamic part of the system-level context of a process in UNIX

(iii) Memory-mapped I/O

7. (a) Assume, Shahid has a 10 MB solid-state drive in his PC. There is currently only one partition and no file in the SSD. The advertised block size of the SSD is 1 MB (1024 KB). Internally the file system layout of the SSD is as follows: **(3×3=9)**

0	1	2	3...9
MBR	Boot block	Super block / FATs	Data blocks

Shahid now wants to create 4 files as described in the following table in the only partition of the SSD.

File Name	Size
A	3.6 MB
B	1.0 MB
C	0.9 MB
D	0.6 MB

How will the file system (installed on his SSD) allocate hard disk blocks to the above files if it uses any of the following allocation schemes? Describe using illustrative figures.

(i) Contiguous allocation

(ii) Linked-List allocation

(iii) Linked-List allocation using a FAT in memory

Contd P/9

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Contd... Q. No. 7

(b) After creating previous files, Shahid now wants to remove file A, C and create a file E of size 5 MB. How the file system installed on his SSD will behave to do so if it uses any of the following allocation schemes? Describe using illustrative figures. **(2×3=6)**

(i) Contiguous allocation

(ii) Linked-List allocation

(iii) Linked-List allocation using a FAT in memory.

(c) Describe the advantages and disadvantages of free space management using bitmap with illustrative examples. **(5)**

(d) Briefly describe the register context of a process in UNIX. **(3)**

(e) "Each buffer in UNIX always exist on a hash queue but not always on the free list" — Justify this statement. Why UNIX kernel maintains these separate data structures? **(3+3=6)**

(f) Why kernel stack needed in addition to user stack? Explain with an illustrative example. **(6)**

8. (a) Give a brief description of the followings: **(3×4=12)**

(i) Y2018 problem in MS-DOS file system

(ii) User-level context of a process in UNIX

(iii) Device Driver

(iv) Device Controller

(b) Describe the "continue" statements in the given algorithm for buffer allocation in UNIX using illustrative examples. **(9)**

```
algorithm getblk
input:  file system number
        block number
output: locked buffer that can now be used for block
{
    while (buffer not found)
    {
        if (block in hash queue)
        {
            if (buffer busy)
            {
                sleep (event buffer becomes free);
                continue;
            }
            mark buffer busy;
            remove buffer from free list;
            return buffer;
        }
```

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Contd... Q. No. 8(b)

```
            else
            {
                if (there are no buffers on free list)
                {
                    sleep (event any buffer becomes free);
                    continue;
                }
                remove buffer from free list;
                if (buffer marked for delayed write) {
                    asynchronous write buffer to disk;
                    continue;
                }

                remove buffer from old hash queue;
                put buffer onto new hash queue;
                return buffer;
            }
        }
}
```

Algorithm for Question 8 (b)

(c) Describe the advantages and disadvantages of free space management using linked list with illustrative examples. **(5)**

(d) How does the UNIX kernel protect its consistency in kernel mode? Describe using illustrative examples. **(6)**

(e) Describe the differences between an in-core inode and a buffer header in UNIX. **(3)**

L-3/T-2/CSE **Date : 31/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **CSE 315** (Microprocessor and Microcontrollers)

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 why 8086 is known as a 16-bit processor whereas Pentium is know as a 32-bit processor. **(7)**

   (b) What are the minimum and maximum modes of operation of 8086 processors? How can the modes be selected? **(8)**

   (c) List different types of addressing modes of 8086. Give one example for each. **(20)**

2. (a) Describe the steps an Intel microprocessor (8086/286/386/Pentium) will take when it responds to an interrupt. **(10)**

   (b) Describe how 8086/286/386 find the address of interrupt service routine (ISR) for an interrupt. **(10)**

   (c) Discuss protected mode memory addressing scheme of 80286 processors. **(15)**

3. (a) How much physical and virtual memory can an 80386 processor address? Explain how 80386 addresses them. **(7)**

   (b) What differences are there when you compare registers of 80386 with that of 80286 processors? **(8)**

   (c) Discuss a 80386 segment descriptor. **(15)**

   (d) What differences has an 80386 descriptor from that of an 80286 descriptor? **(5)**

4. (a) Discuss why Pentium processor is known as a superscalar processor. **(9)**

   (b) Discuss how paging memory management of Pentium is different from that of 80386. **(10)**

   (c) Write short notes on <u>any two</u>: **(8+8=16)**

   (i) Pentium Pro

   (ii) Pentium II

   (iii) Pentium III

Contd P/2

CSE 315

SECTION – B

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

Find the Pin Configuration of A Tmega32 MCU and its different register configurations at the end of the questions.

5. (a) Draw and briefly explain the timing diagrams for the following methods of parallel data transfer **(7+8=15)**

   (i) Single Handshake I/O

   (ii) Double Handshake I/O

   (b) Suppose an 8088 system is connected to a hypothetical input device and a printer via an 8255 PPI. The printer is connected to PORT A and operates in single handshake mode. The hypothetical input device is connected to PORT B and operates in simple I/O mode. Write a pseudo code to continuously read the input device and output it to the printer. Clearly specify the control world. **(10)**

   (c) Suppose two **active high** push switches are connected to PA0 and PA4 of an ATmega32 MCU. Also, eight **active low** LEDS are connected to PORT B. Write a C code to implement an 8 bit counter which counts up when the push switch connected to PA0 is pressed and counts down when the other one is pressed. The output is shown with the LEDs. Use polling approach. You can assume the push switches will not be pressed simultaneously. **(10)**

6. (a) What steps does the CPU follow to execute an interrupt? **(5)**

   (b) Suppose two **active high** push switches A and B are connected to INT0 and INT1 pin of an ATmega 32 MCU, respectively. Also, Eight LEDs, LED0 - LED7 are connected to PB0 - PB7. **(10)**

   Write a C code using external interrupt to implement the following functionality:

   (i) At any instance, only one LED is turned on and initially it is LED0.

   (ii) Pressing push switch A will left **rotate** the Led configuration.
   That is if currently LED2 is on, pressing A will turn LED3 on.

   (iii) Pressing push switch B will right **rotate** the LED configuration.
   That is if currently LED2 is on, pressing A will turn LED1 on.

   The three external interrupt vector names are INT0_vect, INT1_vect, and INT2_vect.

   The codes for external interrupt events are as follows:

Code	Interrupt Triggering Events
00	Low Level
01	Any Logical Change
10	Falling Edge
11	Rising Edge

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Contd... Q. No. 6

(c) How many times TIMER1 will overflow to create a delay of 4s, when: **(3+3+4=10)**

(i) System Clock = 8MHz, no prescalar

(ii) System Clock = 4 MHz, Prescalar = 8

How much time does it take to overflow TIMER1 50 times, with a system clock of 16 MHz and prescalar = 64. Show all the calculations clearly.

(d) Write down the steps to write a byte in ATmega32 EEPROM. **(10)**

7. (a) Consider, you are continuously receiving data from a PC using UART in polling approach. The connection details are: Baud rate: 4800 bps, no parity, 1 stop bit (code: 0), 8 data bits (code: 011), and asynchronous communication (code: 0). Assume a clock speed of 4 MHz. **(3+3+6+3=15)**

(i) Calculate the baud rate.

(ii) Initialize ATmega32 for the given parameters.

(iii) Write a C code that continuously receives a word from the PC, write that word to PORTA, and sleeps for 2 seconds and repeats again.

(iv) If double speed transmission mode is used, what changes are needed to be made in steps a to c?

(b) What is the smallest positive value that can be represented by a 32 bit floating point number in 80×87 Math Coprocessors? Determine both the binary representation and the decimal value. **(10)**

(c) What are the key characteristics of Harvard Architecture? What are its advantages over Von Neumann Architecture? **(10)**

8. (a)(i) Determine the value of TOP and OCR1 (The value at which compare match occurs) to create a 1 KHz signal with 30% duty cycle using Fast PWM modes. The system clock frequency is 4 MHz and prescalar is 8. **(7)**

(ii) Find out the highest frequency that can be achieved using Fast PWM mode to generate a signal of 25% duty cycle. Assume, the system clock frequency is 4 MHz and prescalar is 8. What will be the highest frequency when we increase the duty cycle to 50%. **(8)**

(b) Briefly discuss the in-system flash memory and data SRAM organization of ATmega32 MCU. **(10)**

(c) The digital output of ATmega32 ADC is stored in two 8 bit registers: ADCL and ADCH. While reading the digital output, which one should be read first and why? **(10)**

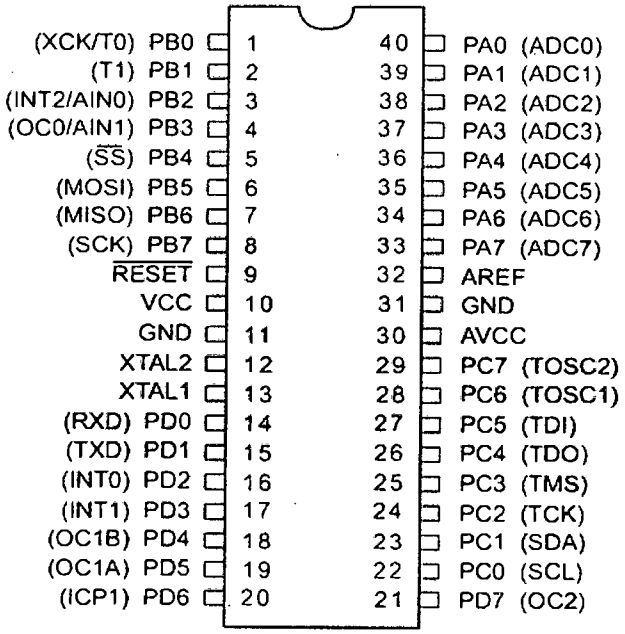

Figure 1. ATmega 32 MCU pinout

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

Table 1 List of registers

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2013-2014

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) Determine the real root of **(17½)**

$$f(x)=4x^3-6x^2+7x-2.3$$

using five iterations of the Bisection method. Employ initial guesses of $x_l=0$ and $x_u=1$. Show the result and approximate relative error for each iteration. You must show detail calculation of the first iteration.

(b) Perform the same computation as in 1(a) but use the False position method. **(17½)**

2. (a) What are the problems associated with the naive Gauss elimination algorithm? Discuss some techniques that can be incorporated into this algorithm to circumvent those problems. **(18)**

(b) Use Gauss elimination to solve. **(17)**

$$4x_1+x_2-x_3=-2$$
$$5x_1+x_2+2x_3=4$$
$$6x_1+x_2+x_3=6$$

Employ partial pivoting (if necessary) and check your answers by substituting them into the original equations.

3. (a) Given the data **(25)**

x	1.6	2	2.5	3.2	4	4.5
$f(x)$	2	8	14	15	8	2

Calculate $f(2.8)$ using Newton's interpolating polynomials of order 1 and 3. Choose the sequence of the points for your estimates to attain the best possible accuracy.

(b) Why are numerical methods necessary for solving engineering problems? Explain this fact using appropriate examples. What are the problems associated with the graphical method in finding the root of an equation? **(2+4+4)**

Contd P/2

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4. (a) What is the main difference between False position method and Secant method? How can be Secant method modified? **(5)**

(b) Explain the salient features of Brent method and Gauss-Seidel method. Write the pseudo code of Gauss-Jordan method. **(5+5+5)**

(c) Determine the real root of $x^{3.5} = 80$ using the modified secant method to be within $\varepsilon_s = 0.1\%$. Employ an initial guess of $x_0 = 3.5$ and $\delta = 0.01$. **(15)**

SECTION – B

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

5. (a) The differential equation $y' = x^2 + y^2 - 2$ satisfies the following data: **(15)**

x	–0.1	0	0.1	0.2
y	1.0900	1.0000	0.8900	0.7605

Use Milne's method to obtain the value of $y(0.3)$. Show two iterations for the corrector step.

(b) Show the flow graph for an 8-point discrete fourier transform (DFT) computation using the Sande-Tukey algorithm. Also, find the DFT of the given sequence $f_k = \{1,3,5,7,7,5,3,1\}$. **(20)**

6. (a) Fit a second-order polynomial to the provided data using the least-squares regression principle. **(12)**

x	0	1	2	3	4	5
y	2.1	7.7	13.6	27.2	40.9	61.1

(b) Use multiple linear regression to fit the following data: **(15)**

x_1	0	0	1	2	0
x_2	0	2	2	4	4
y	15	19	12	11	24

Determine the coefficient of determination to assess the goodness-of-fit.

(c) Show how you can linearize (i) a power equation (ii) a saturation growth rate equation by using a transformation of the provided data. **(8)**

7. (a) Use Romberg integration to evaluate **(12)**

$$\int_0^3 xe^{2x}\,dx$$

to an accuracy of the order of h^6.

Contd P/3

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Contd... Q. No. 7

(b) Integrate the following function both analytically and numerically. Use (i) the trapezoidal rule (ii) Simpson's $\frac{1}{3}$ rule (iii) Simpson's $\frac{3}{8}$ rule. **(15)**

$$\int_0^{\pi} (5+3\sin x)\,dx$$

(c) Write the high-accuracy formulas for forward, backward, and centered approximation to find the first derivative. **(8)**

8. (a) Given the differential equation **(10)**

$$\frac{dy}{dx} = \frac{x^2}{y^2+1}$$

with the initial condition $y = 0$ when $x = 0$.

Use Picard's method of successive approximation to obtain y for $x = 0.5$ with a second approximation of the value of y.

(b) Use (i) the Euler method and (ii) Heun method without iteration to solve the following initial value problem: **(14)**

$$\frac{dy}{dx} = yx^2 - 1.2y$$

from $x = 0$ to 2, where $y(0) = 1$ with a step-size of $h = 1.0$

(c) Use the fourth-order Runge-Kutta method to find the value of $y(0.2)$ for the following initial value problem: **(11)**

$y' = 3x + y/2$ with $y(0) = 1$ and the step-size $h = 0.2$.
