

**University of Dhaka**  
**Department of Computer Science and Engineering**  
**3rd Year 1<sup>st</sup> Semester Final Examination, 2021**  
**CSE-3101: Computer Networking (3 Credits)**

Time: 3 hours

Total Marks: 70

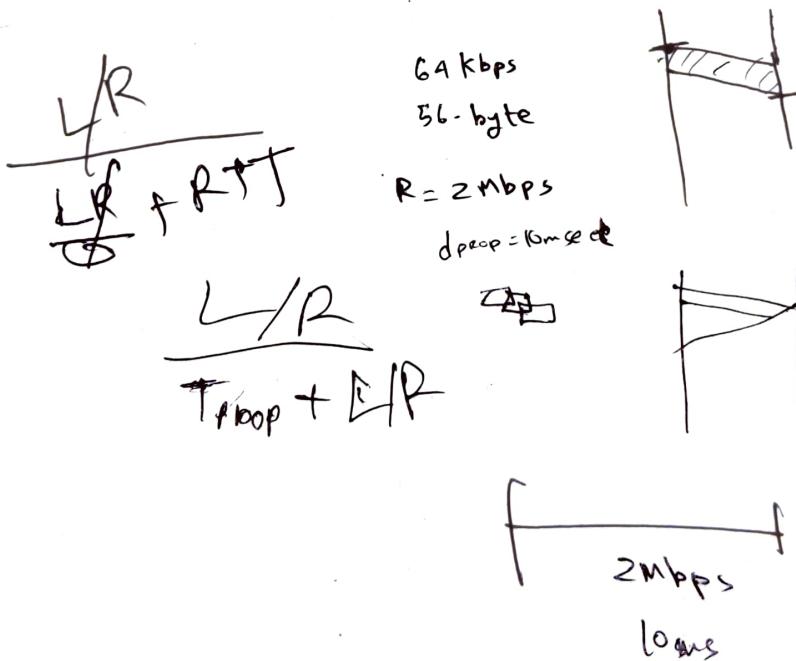
Answer any five (5) out of the following seven (7) questions. Marks are given in the right margin.

1(a) What is the significance of the *bandwidth-delay product*? [2]

$\frac{64}{56} \rightarrow 1$   $1 \rightarrow 64$

(b) Consider sending real-time voice from Host A to Host B over a packet-switched network (VoIP). Host A converts analog voice to a digital 64 kbps bit stream on the fly. Host A then groups the bits into 56-byte packets. There is one link between Hosts A and B; its transmission rate is 2 Mbps and its propagation delay is 10 msec. As soon as Host A gathers a packet, it sends it to Host B. As soon as Host B receives an entire packet, it converts the packet's bit to an analog signal. How much time elapses from the time a bit is created (from the original analog signal at Host A) until the bit is decoded (as part of the analog signal at Host B)? [3]

(c) The Trivial File Transfer Protocol (TFTP) is an application layer protocol that uses the Stop-and-Wait mechanism. To transfer a file from a server to a client, the server breaks the file into blocks of 350 bytes and sends these blocks to the client using Stop-and-Wait. Find the efficiency (defined as the fraction of time the sender is busy sending bits into the channel) in transmitting a large file over a  $1 \times 10^7$  bytes/sec LAN. Assume that the client and the server are 500 meters apart in the LAN and the propagation speed is  $2 \times 10^8$  m/s. There are no transmission errors and each data packet contains 50 bytes of header. Assume that the ACK packets contain no data. [3]



A Wireshark analyzed snapshot of a DNS packet is shown below.

Answer the following questions:

- Can you say whether the answers which the client gets were directly from the DNS server's cache or not?
- How can you tell whether the packet is associated with a particular DNS query?
- What type of DNS query it was?
- There are multiple TTL fields in the packet. What does each TTL mean?

```

Internet Protocol Version 4, Src: 8.8.8.8, Dst: 192.168.1.105
  0100 .... = Version: 4
  .... 0101 = Header Length: 20 bytes (5)
  Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
  Total Length: 154
  Identification: 0x24d5 (9429)
  Flags: 0x00
  Fragment Offset: 0
  Time to Live: 55
  Protocol: UDP (17)
  Header Checksum: 0x8c5d [validation disabled]
  [Header checksum status: Unverified]
  Source Address: 8.8.8.8
  Destination Address: 192.168.1.105
User Datagram Protocol, Src Port: 53, Dst Port: 58796
  Source Port: 53
  Destination Port: 58796
  Length: 134
  Checksum: 0x6cd7 [unverified]
  [Checksum Status: Unverified]
  [Stream index: 9]
  [Timestamps]
  UDP payload (126 bytes)
Domain Name System (response)
  Transaction ID: 0xe240
  Flags: 0x8100 Standard query response, No error
  Questions: 1
  Answer RRs: 4
  Authority RRs: 0
  Additional RRs: 0
  Queries
    ac.bd: type NS, class IN
  Answers
    ac.bd: type NS, class IN, ns jamuna.btcl.net.bd
      Name: ac.bd
      Type: NS (authoritative Name Server) (2)
      Class: IN (0x0001)
      Time to live: 21599 (5 hours, 59 minutes, 59 seconds)
      Data length: 18
      Name Server: jamuna.btcl.net.bd
    ac.bd: type NS, class IN, ns dns.bd
      Name: ac.bd
      Type: NS (authoritative Name Server) (2)
      Class: IN (0x0001)
      Time to live: 21599 (5 hours, 59 minutes, 59 seconds)
      Data length: 6
      Name Server: dns.bd
    ac.bd: type NS, class IN, ns bd-ns.anycast.pch.net
    ac.bd: type NS, class IN, ns surma.btcl.net.bd
  [Request ID: 99]

```

2(a) Suppose Bob joins a BitTorrent torrent, but he does not want to upload any other peers (so called free-riding). [2]

i. Bob claims that he can receive a complete copy of the file that is shared by the swarm. Is Bob's claim possible? Why or why not?

ii. Bob further claims that he can further make his "free-riding" more efficient by using a collection of multiple computers (with distinct IP addresses) in the computer lab in his department. How can he do that?

(b) Packets destined to 203.112.198.23, 203.112.55.4, 203.112.1.1, 10.10.10.10 arrived at a router whose routing table is given below: [4]

Network	Next Hop
203.112.128.0/17	R1
203.112.192.0/18	R3
0/0	R2

How does the router decide the next hops of the packets? [6]

How do FTP work behind a firewall? [1]

(d) Consider a short, 10-meter link, over which a sender can transmit at a rate of 150 bits/sec in both directions. Suppose that packets containing data are 100,000 bits long, and packets containing only control (e.g., ACK or hand shaking) are 200 bits long. Assume that  $N$  parallel connections where each gets  $1/N$  of the link bandwidth. [5]

i. Now, consider the HTTP protocol, and suppose that each downloaded object is 100 Kbits long, and that the initial downloaded object contains 10 referenced objects from the sender. Would parallel downloads via parallel instances of non-persistent HTTP make sense in this case? Justify your answer.

ii. Now, consider persistent HTTP. Do you expect significant gains over the non-persistent case? Justify and explain your answer.

3(a) Unlike RIP, OSPF uses acknowledgement packets. What could be the reasons behind this? [2]

(b) What are the two capabilities supported by RIP 2 but not RIP 1? [2]

(c) Consider a network (running RIP protocol) with a diameter of 9. What will be the average time to propagate the information about a link failure from one end to another? [3]

(d) Consider an application that transmits data at a steady rate for example, the sender generates an  $N$ -bit unit of data every  $k$  time units, where  $k$  is small and fixed. Also, when such an application starts, it will continue running for a relatively long period of time. Answer the following questions and briefly justify your choices. [7]

i. Would a packet-switched network or a circuit-switched network be more appropriate for this application? Why?

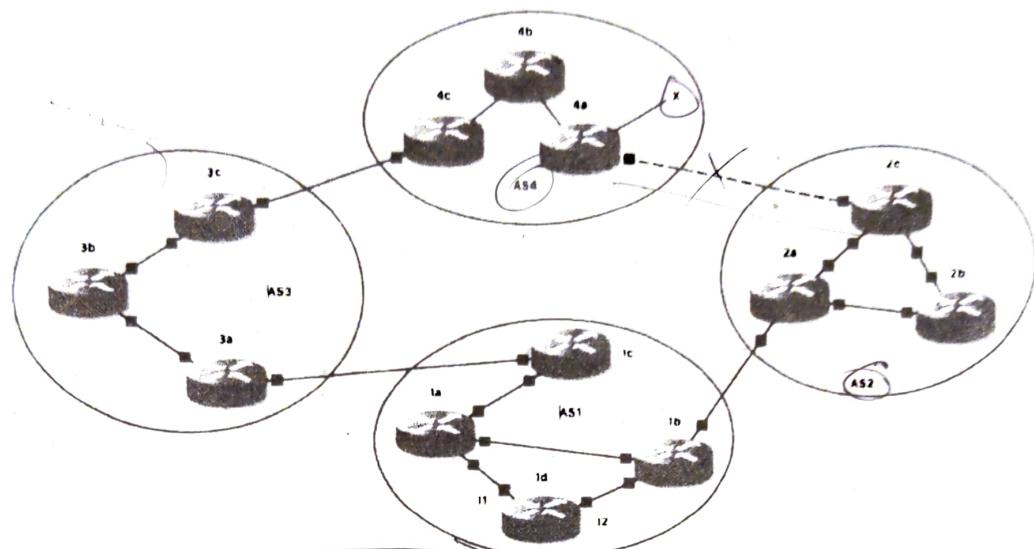
ii. Suppose that a packet-switched network is used and the only traffic in this network comes from such applications as described above. Furthermore, assume that the sum of the application data rates is less than the capacities of each and every link. Is some form of congestion control needed? Why?

203.112.1000 0000  
203.112.1100 --

10000

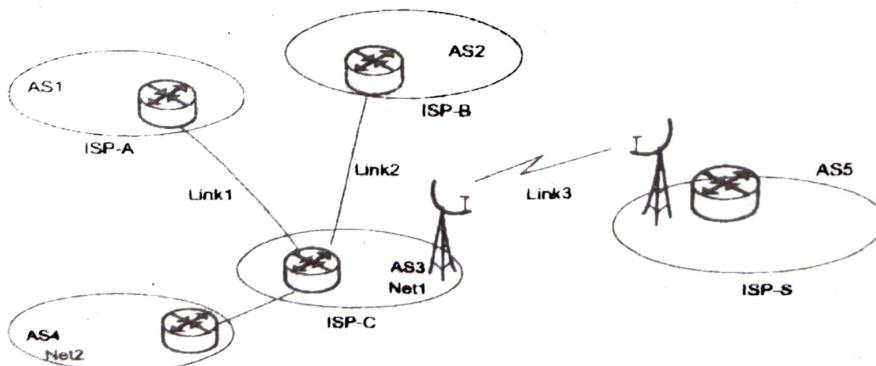
203.112.198

4(a) Consider the network below:

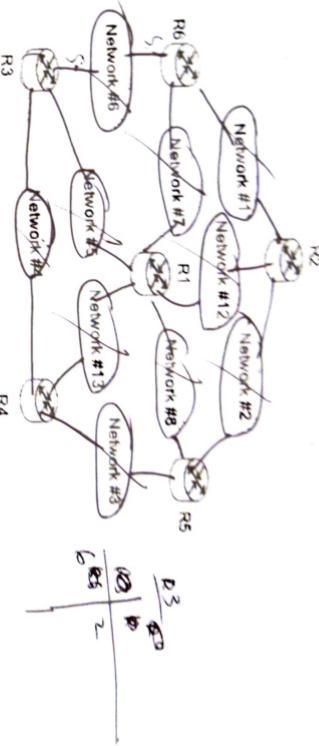


- Now suppose that there is a physical link between AS2 and AS4, shown by the dotted line. Suppose router 1d learns that x is accessible via AS2 as well as via AS3. Will I be set to  $I_1$  or  $I_2$ ? Explain why in one sentence.
- Now suppose there is another AS, called AS5, which lies on the path between AS2 and AS4 (not shown in diagram). Suppose router 1d learns that x is accessible via AS2 AS5 AS4 as well as via AS3 AS4. Will I be set to  $I_1$  or  $I_2$ ? Explain why in one sentence.

- (b) Suppose ISP-C is connected to the Internet through ISP-A and ISP-B using links Link1 and Link2 respectively (see the figure below). Net2 belongs to a client of ISP-C. ISP-C wants incoming traffic for Net2 and Net1 via Link1 and Link2 respectively. Moreover, in order to add redundancy, ISP-C wants Link2 as a backup link for incoming traffic towards Net2. Since the client of ISP-C (AS4) is an influential one and demanded uninterrupted Internet connectivity, the ISP-C decided to connect to ISP-S (which is located to a different country) via a VSAT (link 3). As the data charge of VSAT is very high, ISP-C decides to send/receive only AS4's data through it only in the event when both link 1 and link 2 fails. Otherwise, ISP-C doesn't want to send/receive traffic from the VSAT link. How can this be achieved?



(c) Consider the following network:



Assume all the routers use split horizon mechanism.

- What will be final periodic responses by R3?
- What will be the final periodic responses by R1 when both split-horizon and poison-reverse mechanisms are used by the routers?

5 (a) Briefly describe the fast retransmission and fast recovery algorithms of TCP.

- (b) Consider a TCP flow implementing fast recovery. Assume the end-to-end packet delay is  $d_1$  in both directions. Suppose the 5th packet retransmitted by the sender experiences a delay of  $d_2 > d_1$ . Assume the first packet is transmitted at time  $t$ . What is the congestion window size at time  $t+8*d_1$ ?

- (c) Host A and B are communicating over a TCP connection, and Host B has already received from A all bytes up through byte 128. Suppose Host A then sends two segments to Host B back-to-back. The first and second segments contain 80 and 100 bytes of data, respectively. In the first segment, the sequence number is 1278, the source port number is 302, and the destination port number is 80. Host B sends an acknowledgment whenever it receives a segment from Host A.

- In the second segment sent from Host A to B, what are the sequence number, source port number, and destination port number?
- If the first segment arrives before the second segment in the acknowledgment of the first arriving segment, what is the acknowledgment number, the source port number, and the destination port number?
- If the second segment arrives before the first segment, in the acknowledgment of the first arriving segment, what is the acknowledgment number?
- Suppose the two segments sent by A arrive in order at B. The first acknowledgment is lost, and the second acknowledgment arrives after the first timeout interval.

Draw a timing diagram, showing these segments and all other segments and acknowledgments sent. (Assume there is no additional packet loss.) For each segment in your figure, provide the sequence number and the number of bytes of data; for each acknowledgment that you add, provide the acknowledgment number.

- 6 (a) One of the drawbacks of small packets in Voice-Over-IP applications is that a large fraction of link bandwidth is consumed by overhead. Consider sending a digitally encoded voice source directly. Suppose the source is encoded at a constant rate of 1.28 kbps. Assume each packet (consists of  $P$  bytes of data and 5 bytes header) is entirely filled before the source sends the packet into the network. The time required to fill a packet is the *packetization delay*. Determine the packetization delay in milliseconds.

- (b) Consider a broadcast channel with  $N$  nodes and a transmission rate of  $R$  bps. Suppose the broadcast channel uses polling (with an additional polling node) for multiple access. Suppose the amount of time from when a node completes transmission until the subsequent node is permitted to transmit (that is, the polling delay) is  $d_{poll}$ . Suppose that within a polling round, a given node is allowed to transmit at most  $Q$  bits. What is the maximum throughput of the broadcast channel?

(c) Recall that when there are  $N$  active nodes, the efficiency of slotted ALOHA is  $N_p(1-p)^{N-1}$ . Find the value of  $p$  that maximizes this expression. [3]

(d) Two nodes A and B are connected via a CAN bus. The ID of the nodes are 0x34 and 0x39. Explain with suitable diagram the bus arbitration method of these two nodes. [4]

(a) While surfing the Internet on your laptop through an open wireless access point, you got completely different looks for some popular websites. For example, you typed <http://google.com> but your web browser directed you to some other site. Elaborate (with the help of a diagram) a way to do this kind of trick. Assume that you don't have any virus/Trojan installed in your computer. [4]

(b) Consider distributing a file of 15 Gbits to 12 peers. The server has an upload rate of 30 Mbps, and each peer has a download rate of 2 Mbps and an upload rate of 1 Mbps. Calculate the minimum distribution time for both client-server and P2P file distribution systems. [4]

(c) Suppose there are two ISPs providing WiFi access in a particular café, with each ISP operating its own AP and having its own IP address block. [6]

(i) Further suppose that by accident, each ISP has configured its AP to operate over channel 11. Will the 802.11 protocol completely breakdown in this situation? Discuss what happens when two stations, each associated with a different ISP, attempt to transmit at the same time.

(ii) Now suppose that one AP operates over channel 1 and the other over channel 11. How does your answer change?

## University of Dhaka

### Department of Computer Science and Engineering

3rd Year 1<sup>st</sup> Semester Final Examination, 2021

CSE-3102: Software Engineering (3 Credits)

Total Marks: 70

Time: 3 hours

Answer any five (5) out of the following seven (7) questions. Marks are given in the right margin.

1(a) Describe briefly the function of each tasks of requirement engineering. [5]

- (b) Consider normal operation of an ATM for withdrawing cash. The scenarios are like: a customer inserts the card, enters his/her PIN, enters the amount, takes the card, and takes the money.

Identify the main actors and give the use-cases.

(c) The paragraph given below describes the functionality of an auction web-market with the following features:

Sellers publish offerings with product descriptions and sales conditions. Buyers search with a hierarchy of categories or with free-text keywords. Buyers can bid on offerings. Sellers can sell to highest bid or at fixed price. Sellers can be business sellers or private persons. Buyers can rate sellers.

Identify functional and non-functional requirements of the system.

2(a) Consider the operation of a vending machine.

The main function of a vending machine is to allow a customer to buy product(s) from the machine (candy, chocolate, soda, juice etc.) When the customer wants to buy some of the products offered by the vending machine, he/she inserts money into the machine, selects one or more products, and the machine dispenses the selected product(s) to the customer. If the products cost less than the amount of money that customer put in the machine, the vending machine shall dispense change. Also, the vending machine needs to be restocked when it runs out of certain products. In addition, there must be a provision for a person (say, a collector) to collect money from the vending machine.

- (i) Identify the main actors.  
(ii) Draw the Use Case Diagram for the above scenario.

- (b) Create an UML activity diagram modeling a student applying for a job describing the following scenario: The student is writing a letter that is sent to the company. The company registers the application and a manager takes a decision if the student should be interviewed or not. If the student should be interviewed the manager books a meeting time. In both cases, the student gets an e-mail with a response to the application. If the student is called to the interview, he will get the response if he got the job at this meeting. At the same time as the company manages the application, the student is taking a course at the university. If the student accepts the job he will start at the company after the course is finished. Divide the diagram into suitable swimlanes and give proper names.

- 3 (a) A group of diary and time management system intended to support the timetabling of meetings and appointments across a group of co-workers. When an appointment is to be made that involves a number of people, the system finds a common slot in each of their diaries and arranges the appointment for that time. If no common slots are available, it interacts with the user to rearrange his or her personal diary to make room for the appointment.

Identify possible objects (including attributes and operations) in the above system and develop an object-oriented design for them.

(b) Consider the following scenario:

A Blood Bank collects blood and tests all blood for blood type and potential viral agents. The results of these tests are sent to a processing officer. For each tested blood unit, he fills out a form that lists the blood unit number, the blood type, the date and the results of the test and this information is stored in a database. If the tests indicate that the blood may be contaminated with a viral agent, the blood unit is destroyed. This is indicated on the test form.

A number of hospitals make request for blood to the bank. A processing officer prepares a listing for each hospital and the specific types of blood to supply to the hospital. If the blood for specific type is available, the bank prepares refrigerated containers of these units and distributes them to the hospital vans which they arrive to pick up their supply. When the order is filled, the lab technician signs the order and returns a copy to the processing officer. A copy of it travels with the blood to the requesting hospital. The final copy is kept in the Blood Bank records but discarded after one year.

Draw the context level DFD and Level-1 DFD.

Discuss various types of coupling. What are the problems if coupling between two modules is high?

[5]

(b) Give two arguments of why it is good to have high cohesion and low coupling amongst software modules.

[5]

(c) A system architecture is often described using multiple views. Why is this beneficial?

[4]

5 (a) Software testing activities boils down to selecting and executing test cases. Identify five key elements of a test case.

[5]

(b) Design black box test suits for a function that checks whether a character or string upto ten characters is a palindrome.

[6]

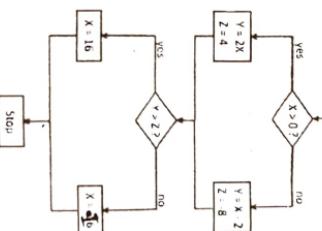
(c) Differentiate between white-box and black-box testing.

[3]

6 (a) When and how often in the lifecycle does verification and validation activities take place? Which members of the team are typically in charge of each one? Explain briefly.

[5]

Consider the flowgraph below describing a function with an input variable X and output variables X, Y and Z. Write down two sets of test cases. The first set of test cases shall guarantee that all statements are executed at least once, using a minimum number of test cases. The second set of test cases shall guarantee that all paths of the flowgraph are traversed at least once.



[5]

(c) Create a short risk management plan for a software development project. The plan should include one technology risk, one business risk, and one project risk. There are two strategies for accepting a risk. For each of the 3 risks, write down one example for each strategy.

[5]

Define role, task, work package and explain different communication strategies.

[5]

(d) Give the basic principle for project scheduling. Why critical path and slack time is important in project scheduling.

[5]

(e) A problem estimates unadjusted function point as 18, value added factor as 0.87, and performance factor as 2. Find the effort in person days.

[4]

# University of Dhaka

## Department of Computer Science and Engineering

3rd Year 1st Semester Final Examination, 2021

### CSF-3103: Microprocessor and Microcontroller (3 Credits)

Time: 3 hours Total Marks: 70

Answer any five (5) out of the following seven (7) questions.

1. (a) Convert the following ARM assembly code into machine language. Write the instruction in hexadecimal.

(i) LDR R4,R8,R6      ~~E4A44444~~      E 1 C 0 4 6 3 8

(ii) LDR R11,[R3,#4]      ~~E5959595~~      E E 9 3 B 0 0 4

(iii) 0xE2?75058      ~~95959595~~      E 5 9 3 B 0 0 4

(iv) 0xE3A0?0201F      ~~40404040~~      E 1 A 0 4 0 0 2

(c) Consider the following ARM assembly language snippet. The numbers to the left of each instruction indicate the instruction address.

0x0000A00028 fmove1 M0V R4, R1      [6]

0x0000A0002C ADD R5, R3, R5, LSR #2

0x0000A00030 SUB R4, R0, R3, ROR R4

0x0000A00034 BL fmove2

... ...

\*0x0000A00038 fmove2 LDR R2, [R0,#4]

\*0x0000A0003C STR R2, [R1,-R2]

4x0000A00040 CMP R3, #0

0x0000A00044 BNE else

0x0000A00048 MOV PC, LR

0x0000A0004C else SUB R3, R3, #1

0x0000A00050 B fmove2

(i) Translate the instruction sequence into machine code. Write the machine code in binary.

(ii) List the addressing mode used at each line of code.

(d) The high-level function strcpy copies the character string src to the character string dst

// C code

```
void strcpy(char dst[], char src[]) {  
    int i = 0;  
    do {  
        dst[i] = src[i];  
    } while (src[i++]);  
}
```

Implement the strcpy function in ARM assembly code. Use R4 for i.

[4]

2. (a) A subroutine is passed two integer parameters which it adds together and returns the result in R0. Assuming that the subroutine places the Link Register (LR) on the stack and uses the stack to pass the parameters, sketch the ARM code required for a simple implementation of the subroutine and draw diagrams of the resulting stack structure.

- (b) The following code is an implementation of Euclid's GCD algorithm. [This calculates the Greatest Common Divisor also known as the Highest Common Factor of two numbers e.g. 6 and 9 would give 3.]
- ```
gcd CMP R0, R1  
BEQ end  
BLT less  
SUB R0, R0, R1  
B ge1  
less SUB R1, R1, R0  
B ge1  
end
```

Rewrite the code using conditionally executed instructions.

- (c) Design an algorithm for testing whether a given string is a palindrome. Implement your algorithm using ARM assembly code. [5]

3. ~~✓~~ Describe all the special registers of cortex M4 processor with suitable diagram. [6]

- (a) Explain in details the bus interfaces of cortex M4 processor. [4]

(c) Draw the cortex M4 block diagram and write down the functionality of FPU and MPU. [4]

4. (a) Explain tail chaining with a timing diagram. [4]

(b) Assume an interrupt EXTI X has the position 17 in interrupt vector table. What is the entry address for EXTI X? [2]

- (c) Write down the assembly instruction to disable all the interrupts with priority level equal or lower than 0x30. [2]

(d) Describe with a proper diagram the procedure to handle exception in thread mode. [6]

5. About clock and timer configuration. [4]

(a) A microcontroller has a 16MHz ~~external~~ crystal, and the clock configuration for the system uses a clock generated from the PLLCLK module of the microcontroller. The microcontroller has AHBL1, APBL1, and APB2 pins to connect peripherals. The peripherals connected to the AHBL1 bus need an 80MHz clock. At the same time, APB2 and APB1 need clocks of 40 and 20 MHz accordingly. Determine the Prescaler values given in the following tables. [4]

| Sequence | Prescaler            | Possible values                                                     |
|----------|----------------------|---------------------------------------------------------------------|
| 1        | PLLM, PLLN, PLLP     | $2 \leq PLLM \leq 63, 50 \leq PLLN \leq 432, PLLP \in [2, 4, 6, 8]$ |
| 2        | System Clock Mask    | HSI, HSE, PLLCLK or PLLR                                            |
| 3        | AHB Prescaler (HPRE) | $HPRE \in [2, 4, 8, 16, \dots, 512]$                                |
| 4        | APB1 Prescaler       | $PPRE1 \in [2, 4, 8, 16]$                                           |
| 4        | APB2 Prescaler       | $PPRE2 \in [2, 4, 8, 16]$                                           |

$$16 \times 4 \times 16 \times \frac{1}{2}$$

(b) The timer is an independent peripheral and is not influenced by the code running on the microprocessor unless the code modifies its configuration. A timer can generate PWM signals as needed by any application. One application lets APBx need a PWM signal that comprises five pulses with duty cycles 20%, 25%, 35%, 40% and 50% accordingly. Determine the ~~CCR1~~ Prescaler and ~~BRR~~ Registers values for the up counter setting of a timer to generate the PWM signal with the given pattern. Note that an MCU changes polarity (low to high or high to low) whenever the CNT register matches the CCR1 register value. Assume that the input clock of the timer is 80MHz, and the generated target pulses (five altogether) take exactly five microseconds. [5]

(c) Two pushdown switches (down represents 1) are connected to pin PA5 and PA6. Four LEDs are connected to GPIO port B (PB1, PB2, PB3, and PB4). Determine the values of RCC\_AHBENR, GPIOX\_MODER, GPIOX\_OTYPER, GPIOX\_OSPEEDR registers. Write a segment of code to recognize the input switches combinations, such as to light on LEDs following the conditions given in the following table. Assume that bit-'0' to bit-'7' must be configured to enable GPIOA to GPIOH. Starting from bit-'0' to bit-'3' (2-bit for each pin) of GPIOX\_SPEEDR and GPIOX\_MODER registers represent pin '0' to '15'. However, bit-'0' to bit-'15' needs to configure for pin-'0' to pin-'16' of GPIOX\_OTYPER register. In addition, bit-'0' to '15' for set and '16' to '31' reset the 16 GPIO pins. [5]

Input (PA5 PA6) LED Status (PB1 PB2 PB3 PB4)

|    |                |
|----|----------------|
| 00 | on off off off |
| 01 | off on off off |
| 10 | off off on off |
| 11 | off off off on |

6. Answer the following questions based on UART deployment in the STM32F146rc microcontroller.

- (a) A UART slave device is connected to the MCU and MCU can read from and write values to the device registers. MCU writing value to the register of the slave device primarily to configure the device and read a register value from the device (such as sensing the speed of the jet engine of an aircraft). However, the device only accepts a baud rate of exactly 5Mbps. Determine the mantissa and fractional values for the USARTx\_BRR register to

set the baud rate. Assume that the register accepts 12-bits for mantissa and only 4-bits for the fractional value. [3]

- (b) Write a program to configure a UART communication with a baud rate 5MBps to the Jet Engine. Assume that in response to transferring 0x5C to the Jet engine, the Jet engine sends 3KBytes of data to the MCU that contains speed (in rpm), engine health information, angle to the ground height from the sea level, and GPS position. Assume that the controller uses USART6 of MCU with PC6 for Tx and PC7 for Rx. The alternate function for PC6 and 7 is AF8 (0x08). The registers for the alternate function are GPIOx\_AFRL for '0' to '7' pins and GPIOx\_AFRH for '8' to '15' pins. RCC\_APB2ENR bits 4 and 5 for USART1 and 6 clocks enable. The USART registers are listed as follows (SR, CR1, CR2, CR3) [8]

|       |           |       |      |      |      |        |       |      |        |        |      |      |      |       |          |      |     |
|-------|-----------|-------|------|------|------|--------|-------|------|--------|--------|------|------|------|-------|----------|------|-----|
| 31    | 30        | 29    | 28   | 27   | 26   | 25     | 24    | 23   | 22     | 21     | 20   | 19   | 18   | 17    | 16       |      |     |
| 15    | 14        | 13    | 12   | 11   | 10   | 9      | 8     | 7    | 6      | 5      | 4    | 3    | 2    | 1     | 0        |      |     |
|       |           |       |      |      |      | CTS    | LBD   | TXE  | TC     | RXNE   | IDLE | ORE  | NF   | FE    | PE       |      |     |
|       |           |       |      |      |      | PC_W0  | PC_W0 | r    | PC_W0  | PC_W0  | r    | r    | r    | r     | r        |      |     |
| 31    | 30        | 29    | 28   | 27   | 26   | 25     | 24    | 23   | 22     | 21     | 20   | 19   | 18   | 17    | 16       |      |     |
| 15    | 14        | 13    | 12   | 11   | 10   | 9      | 8     | 7    | 6      | 5      | 4    | 3    | 2    | 1     | 0        |      |     |
| OVER8 | UE        | M     | WAKE | PCE  | PS   | PEIE   | TXEIE | TCE  | RXNEIE | IDLEIE | TE   | RE   | RWU  | SBK   |          |      |     |
| rw    | rw        | rw    | rw   | rw   | rw   | rw     | rw    | rw   | rw     | rw     | rw   | rw   | rw   | rw    |          |      |     |
| 31    | 30        | 29    | 28   | 27   | 26   | 25     | 24    | 23   | 22     | 21     | 20   | 19   | 18   | 17    | 16       |      |     |
| 15    | 14        | 13    | 12   | 11   | 10   | 9      | 8     | 7    | 6      | 5      | 4    | 3    | 2    | 1     | 0        |      |     |
| LINEN | STOP[1:0] | CLKEN | CPOL | CPHA | LBCL | Res.   | LBDIE | LBDL |        |        |      |      |      |       | ADD[3:0] |      |     |
| rw    | rw        | rw    | rw   | rw   | rw   | rw     | rw    | rw   |        |        |      |      |      |       |          |      |     |
| 31    | 30        | 29    | 28   | 27   | 26   | 25     | 24    | 23   | 22     | 21     | 20   | 19   | 18   | 17    | 16       |      |     |
| 15    | 14        | 13    | 12   | 11   | 10   | 9      | 8     | 7    | 6      | 5      | 4    | 3    | 2    | 1     | 0        |      |     |
|       |           |       |      |      |      | ONEBIT | CTSIE | CTSE | RTSE   | DMAT   | DMAR | SCEN | NACK | HDSEL | IRLP     | IREN | EIE |
|       |           |       |      |      |      | rw     | rw    | rw   | rw     | rw     | rw   | rw   | rw   | rw    | rw       | rw   |     |

- (c) To set the USART reception interrupts, describe the bits that need to be set and check the interrupt service routine. Also, mention when the interrupt service routine for reception is activated. [3]

7. Answer the following questions on I2C?

- (a) Let an I2C master is connected to 32 slaves where each of the I2C slave maintains two addresses: (i) unique slave address and (ii) broadcast address. The broadcast address is 0xFF, and device addresses are assigned from 1 to 31. Configure both addresses for the I2C slaves. Assume that ORA1 and ORA2 contains one of the 7 and 10 bits address. The ORA1: bit-0 is ADDR0, bits-1-7 ADD[7:1] and ADD[8:9] are used for interface address, and bit-15 is the addressing mode (ADD MODE). Bit-0 of ORA2 is the EN\_DUAL, and bit-1 to 7 bits are used for the interface address. Also, draw the packet for writing 0x4C to a register (memory) identified address of 0XD5. [6]
- (b) How could a differential between start, stop, and data in I2C. If an MCU wants to read three registers values with 0xC0, 0xD0, and 0xA1 addresses, then determine the minimum number of start and stop signals that need to transfer by the master to the slave where the slave address is 0x0A. [4]
- (c) When does the slave or master stretch the clock signals (down the clock and hold)? If a master-slave communication is disrupted by clock stretching, write down the steps to release the clock to reset the I2C to the normal operational stage. For every byte of data, master, and slave exchange acknowledgment bit. Do you think the acknowledge bits play a vital role in synchronization? Explain. [4]

| Mnemonic | Opcode | Op |
|----------|--------|----|
| ADD      | 0100   | 00 |
| SUB      | 0010   | 00 |
| MOV      | 1101   | 00 |
| BL       | 1110   | 10 |
| BNE      | 0001   | 10 |
| STR      | 1110   | 01 |
| LDR      | 1110   | 01 |
| LSR      | 1110   | 00 |
| CMP      | 1010   | 00 |
| B        | 1110   | 10 |
| BLT      | 1011   | 10 |

**University of Dhaka**  
**Department of Computer Science and Engineering**  
**3rd Year 1<sup>st</sup> Semester Final Examination, 2021**  
**CSE-3104: Database Management Systems II (3 Credits)**

Time: 3 hours

Total Marks: 70

Answer any five (5) out of the following seven (7) questions. Marks are given in the right margin.

- 1 (a) What factors should be considered while choosing RAID levels? Compare RAID level 0, 1 and 5 with respect to these factors. [5]
- (b) Consider the deletion of record 5 from the file of Fig 1. Compare the relative merits of the following techniques for implementing the deletion: [3+3]

|           |       |            |            |       |
|-----------|-------|------------|------------|-------|
| record 0  | 10101 | Srinivasan | Comp. Sci. | 65000 |
| record 1  | 12121 | Wu         | Finance    | 90000 |
| record 2  | 15151 | Mozart     | Music      | 40000 |
| record 11 | 98345 | Kim        | Elec. Eng. | 80000 |
| record 4  | 32343 | EI Said    | History    | 60000 |
| record 5  | 33456 | Gold       | Physics    | 87000 |
| record 6  | 45565 | Katz       | Comp. Sci. | 75000 |
| record 7  | 58583 | Califeri   | History    | 62000 |
| record 8  | 76543 | Singh      | Finance    | 80000 |
| record 9  | 76766 | Crick      | Biology    | 72000 |
| record 10 | 83821 | Brandt     | Comp. Sci. | 92000 |

Fig. 1

- i) Move record 6 to the space occupied by record 5, and move record 7 to the space occupied by record 6 and so on.
- ii) Move record 10 to the space occupied by record 5.
- iii) Mark record 5 as deleted, and move no records.

How free list can help to solve the problem? Explain with figures.

- (c) What is metadata? How it helps manipulating a database? [3]
- 2 (a) Consider the relation given below and the table X. Construct a B+ tree with N = 4, for indexing the table entries to perform the following query efficiently: [9]

Select \* from X where Account Number = "AD0200001"

| Account Number | Customer Name | Branch Name | Balance (Million) |
|----------------|---------------|-------------|-------------------|
| AD0200019      | ABC           | C.DU        | 5                 |
| AD0200027      | ABD           | T.DU        | 7                 |
| AD0200001      | ABB           | N.K.D       | 7                 |
| AD0200021      | ABE           | RB.DU       | 9                 |
| AD0200025      | ABBCD         | C.DU        | 3                 |
| AD0200003      | ABER          | T.DU        | 5                 |
| AD0200009      | YAJ           | T.DU        | 6                 |
| AD0200008      | KAL           | RB.DU       | 77                |
| AD0200007      | PLL           | C.DU        | 89                |
| AD0200010      | BPL           | C.DU        | 90                |
| AD0200018      | IPL           | C.DU        | 23                |
| AD0200015      | MPL           | N.K.D       | 24                |
| AD0200013      | MMPL          | RB.DU       | 54                |
| AD0200030      | XPL           | N.K.D       | 57                |

- (b) Analyze the computational complexity of performing a query in a B+ tree with the node size N. Calculate the cost of performing the query stated in 2(a) with respect to the number of nodes accessed in a B+ tree during the query. [8]
- 3 (a) Let relations Patient (ID, Name, Address, Age) and Doctor (ID, Dept, Salary, Degree) have the following properties  
X The patient has 50000 tuples and needs 800 blocks in the secondary storage  
The doctor has 20000 tuples and needs 500 blocks in the secondary storage. [7]

nested relation  $\rightarrow$  no relation with attribute

|   |        |
|---|--------|
| A | B      |
| a | (a, b) |

Perform Patient  $\bowtie$  Doctor using the merge join algorithm when relations are not sorted according to ID (consider the cost of the last write operation for sorting).

Compare the cost of the merge join algorithm with the nested and block nested-loop join algorithms.

Assume: M = 4 blocks, tS = 5 msec. and tT = 0.2 msec.

- (b) With examples, show the differences among schedules, serial schedules, and serializable schedules. [3]
- (c) Consider the below-given schedule S. Proof and check whether it is conflict serializable or not? Also, check for the view serializability of the schedule. [4]

| Transaction 1                        | Transaction 2                             |
|--------------------------------------|-------------------------------------------|
| Read (A)<br>A := A - 50<br>Write (A) |                                           |
|                                      | Read(B)<br>B := B - B * 0.1<br>Write (B)  |
| Read (B)<br>B := B + 50<br>Write (B) |                                           |
|                                      | Read (A)<br>A := A + A * 0.1<br>Write (A) |

- 4 (a) ✓ 'Throughput' and 'response time' are two important performance measures of a database. How parallel systems help to improve these measures with respect to query processing? [2]
- (b) ✓ Explain the factors that affect speedup and scaleup in parallel databases. [4]
- (c) ✓ Compare 'shared memory' and 'shared disk' as parallel database architecture. [4]
- (d) ✓ What are the benefits and limitations of using distributed database? [4]
- 5 (a) ✓ Define the terms: i) interquery parallelism ii) intraquery parallelism. [3]
- (b) ✓ Describe the strategy for Range Partitioning Sort. How it differs from Parallel External Sort-Merge strategy? [5]
- (c) ✓ When should we use Fragment-and-Replicate join? What is Asymmetric Fragment-and-Replicate join? [3]
- (d) ✓ What is network partition in distributed databases? How it can be handled? [3]
- 6 (a) ✓ What are the purposes of using a data warehouse? Describe benefits and drawbacks of a source-driven architecture for gathering of data at a data warehouse, as compared to a destination-driven architecture. [4]
- (b) ✓ What do you understand by OLAP? Distinguish between the OLAP operation: [6]
  - i) Slicing and dicing
  - ii) cube and rollup
- (c) ✓ How do you define data mining? Briefly mention some of the applications of data mining. [4]
- 7 (a) ✓ What are the differences between object-relational database and object-oriented database? [3]
- (b) ✓ What different complex data types are handled by the extensions to SQL that usual relational model does not support. Explain with a suitable example. [5]
- (c) ✓ What do you understand by 'nesting' and 'unnesting'? [2]
- (d) ✓ What is persistent programming language? How it differs from embedded SQL? [4]

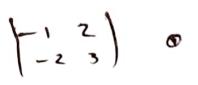
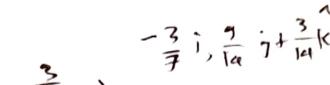
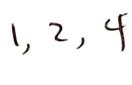
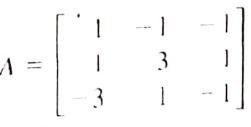
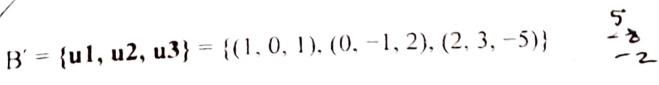
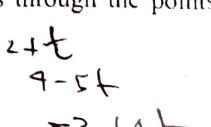
$$x^2 + y^2 = 9 - k^2$$

**University of Dhaka**  
**Department of Computer Science and Engineering**  
**3rd Year 1<sup>st</sup> Semester Final Examination, 2021**  
**MATH-3105: Multivariable Calculus and Geometry (3 Credits)**

**Time: 3 hours**

**Total Marks: 70**

**Answer any five (5) out of the following seven (7) questions. Marks are given in the right margin.**

- Q(a)** What region in  $R^3$  is represented by the following inequalities?  [4]
- $$1 \leq x^2 + y^2 + z^2 \leq 4, z \leq 0$$
- (b)** Using the idea of Change of Basis, find the transition matrix from B to B' for the bases for  $R^2$  below.  [5]
- $$B = \{(-3, 2), (4, -2)\} \text{ and } B' = \{(-1, 2), (2, -2)\}$$
- (c)** Find the scalar and vector projections of:  $b = \langle 1, 1, 2 \rangle$  onto  $a = \langle -2, 3, 1 \rangle$ .  [5]
- 2 (a)** What is the relationship between the *spanning set* and *basis* of vector space? [2]
- (b)** Consider the linear transformation  $T: R^n \rightarrow R^m$  represented by  $T(\mathbf{x}) = A\mathbf{x}$ . Find the nullity and rank of  $T$ , and determine whether  $T$  is one-to-one, onto, or neither. [6]
- a.**  $A = \begin{bmatrix} 1 & 2 & 0 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix}$   [1]
- b.**  $A = \begin{bmatrix} 1 & 2 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}$   [1]
- c.**  $A = \begin{bmatrix} 1 & 2 & 0 \\ 0 & 1 & -1 \end{bmatrix}$   [1]
- d.**  $A = \begin{bmatrix} 1 & 2 & 0 \\ 0 & 1 & 1 \\ 0 & 0 & 0 \end{bmatrix}$   [1]
- (c)** Let  $T: R^5 \rightarrow R^4$  be defined by  $T(\mathbf{x}) = A(\mathbf{x})$ , where  $\mathbf{x}$  is  $R^5$  and  [6]
- $$A = \begin{bmatrix} 1 & 2 & 0 & 1 & -1 \\ 2 & 1 & 3 & 1 & 0 \\ -1 & 0 & -2 & 0 & 1 \\ 0 & 0 & 0 & 2 & 8 \end{bmatrix}$$
- Find a basis for the range of  $T$ .
- 3 (a)** Show that the matrix  $A$  is diagonalizable.  [3]
- Then find a matrix  $P$  such that  $P^{-1}AP$  is diagonal.  [4]
- (b)** Sketch the level curves of the function:  $g(x, y) = \sqrt{9 - x^2 - y^2}$  for  $k = 0, 1, 2, 3$  [4]
- (c)** Find the coordinate matrix of  $\mathbf{x} = \langle 1, 2, -1 \rangle$  in  $R^3$  relative to the non-standard basis:  [4]
- 4 (a)** Find an equation of the plane that passes through the points:  $P(1, 3, 2)$ ,  $Q(3, -1, 6)$  and  $R(5, 2, 0)$ .  [5]
- (b)** Find parametric equations and symmetric equations of the line that passes through the points  $A(2, 4, -3)$  and  $B(3, -1, 1)$ .  [4]

- (c) Find the distance between the parallel planes  $x + 2y - 3z = 4$  and  $2x + 4y - 6z = 3$ . [5]
- 5 (a) What is the difference between standard basis and nonstandard basis? Explain with an example. [2]
- (b) Find the directional derivative of the function at the given point in the direction of the vector  $\mathbf{v}$ :  
 $f(x, y) = e^x \sin y, (0, \pi/3), \mathbf{v} = \langle -6, 8 \rangle$
- ~~$\alpha = 35^\circ, \theta = 0^\circ$~~
- (c) If  $f(x, y) = xe^y$ , find the rate of change of  $f$  at the point  $P(2,0)$  in the direction from  $P$  to  $Q(1/2, 2)$ . [6]
- 6 (a) Find the local maximum and minimum values and saddle point(s) of the function  
 $f(x, y) = x^2 + xy + y^2 + y$ . [7]
- (b) Find the absolute maximum and minimum values of the function  $f(x, y) = x^2 - 2xy + 2y$  on the rectangle  $D = \{(x, y) \mid 0 \leq x \leq 3, 0 \leq y \leq 2\}$  [7]
- 7 (a) Find the points on the sphere  $x^2 + y^2 + z^2 = 4$  that are closest to and farthest from the point  $(3, 1, -1)$ . [6]
- (b) Compute the following double integral:  

$$\iint_R 6xy^2 dA, R = [2, 4] \times [1, 2]$$
- (c) Find the tangent plane to the elliptic paraboloid  $z = 2x^2 + y^2$  at the point  $(1, 1, 3)$ . [4]