University of Dhaka
Department of Computer Science and Engineering
3rd Year 1st Semester B.Sc. Final Examination, 2020
CSE 3101: Computer Networking

Full Marks: 70   Time: 2 hours

Answer any 3 (three) of the following questions

1. a) What do you mean by handshaking protocol? Why do HTTP, FTP, SMTP and POP3 run on top of TCP rather than UDP?   **6**

    b) Describe how Web caching can reduce the delay in receiving a requested object. Will Web caching reduce the delay for all objects requested by a user or for only some of the objects? Why or why not?   **5**

    c) Consider a packet of length L which begins at end system A and travels over three links to a destination end system. These three links are connected by two packet switches. Let d_i, s_i, and R_i denote the length, propagation speed, and the transmission rate respectively of link i, for i = 1, 2, 3. The packet switch delays each packet by d_{proc}. Assuming no queuing delays, in terms of d_i, s_i, R_i, (i = 1,2,3), and L, what is the total end-to-end delay for the packet?   **6.33**

Suppose now the packet is 1,500 bytes, the propagation speed on all three links is 2.5×10^8 m/s, the transmission rates of all three links are 2 Mbps, the packet switch processing delay is 3ms, the length of the first link is 5,000 km, the length of the second link is 4,000 km, and the length of the last link is 1,000 km. Calculate the end-to-end delay.

    d) Describe how a botnet can be created, and how it can be used for a DDoS attack.   **6**

2. a) What are the two most important network-layer functions in a datagram network? What are the three most important network-layer functions in a virtual circuit network?   **7**

    b) Suppose an application generates chunks of 40 bytes of data every 20ms, and each chunk gets encapsulated in a TCP segment and then an IP datagram. What percentage of each datagram will be overhead, and what percentage will be application data?   **5.33**

    c) Compare and contrast link-state and distance-vector routing algorithms.   **6**

    d) It has been said that when IPv6 tunnels through IPv4 routers, IPv6 treats the IPv4 tunnels as link-layer protocols. Do you agree with this statement? Why or why not?   **5**

3. a) What is the significance of the *bandwidth-delay product*?   **2**

    b) A Wireshark analyzed snapshot of a DNS packet is shown below. Answer the following questions: **8**

      i. Can you say whether or not the answers which the client gets were directly from DNS server's cache?

      ii. How can you tell whether the packet is associated with a particular DNS query?

      iii. What type of DNS query it was?

      iv. 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: 0x8180 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 In: 99]
```

c) How can an HTTP client automatically select in which language an HTML page is to be displayed (provided that the server has the document available in more than one language?

3

d) 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?

e) How does FTP work behind a firewall?   4

f) The initial sequence number (ISN) of a TCP session is generated at random. What may happen if the ISN is fixed (say 1)?   2.33

4 a) Suppose you are going to deploy an adhoc routing protocol for a vehicular network (VANET). What type of routing protocol (i.e. reactive or proactive) is suitable for this purpose? Justify your answer.   3

b) Consider the following two disjoint networks (Fig. 1):   7
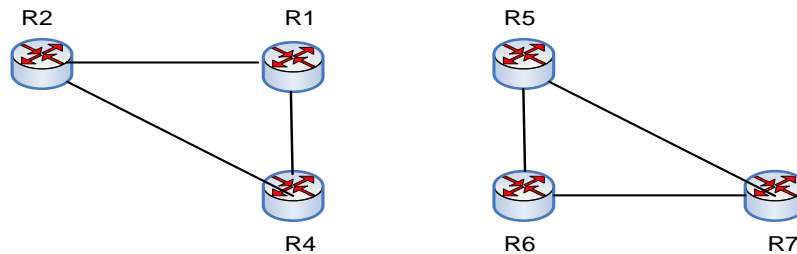
Fig. 1

Now assume that a system administrator has just connected R1 and R5 using a serial link. Show the sequence of the OSPF messages exchanged by R1 and R5.

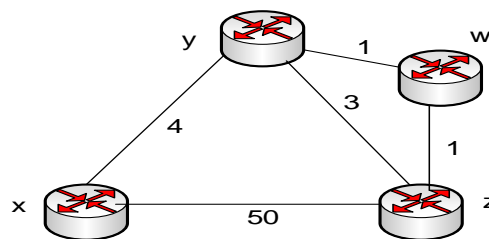c) Consider Fig. 2 to answer the following questions. The costs of all links are given   3+4+3

Fig. 2

as follows: $c(x, y) = 4$, $c(x, z) = 50$, 50, $c(y, w) = 1$, $c(z, w) = 1$, $c(y, z) = 3$. Suppose that poisoned reverse is used in the distance-vector routing algorithm.

i. When the distance vector routing is stabilized, router w, y, and z inform their distances to x to each other. What distance values do they tell each other?

ii. Now suppose that the link cost between x and y increases to 60. Will there be a count-to-infinity problem even if poisoned reverse is used? Why or why not? If there is a count-to-infinity problem, then how many iterations are needed for the distance-vector routing to each a stable state again? Justify your answer.

iii. How do you modify $c(y, z)$ such that there is no count-to-infinity problem at all if $c(y, x)$ changes from 4 to 60?

d) When do you need a DR and a BDR in OSPF? 3.33

5 a) Unlike RIP, OSPF uses acknowledgement packets. What could be the reasons behind this? 3.33
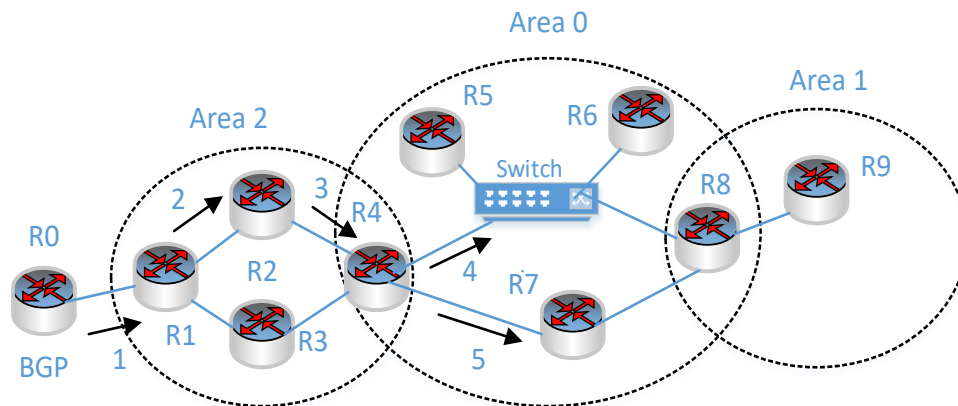
6.

Fig 3

The figure above shows a network topology where all the routers are running OSPFv2 routing protocol. The routers are organized in three areas (area 0 – 2). R0 is connected to the internet and is also running BGP in order to connect to ISP's BGP4 router. The arrows (numbered 1-6) show some link state advertisement packets. For each of the arrows, write down the types of LSAs (consider only type 1-5) and give the reason behind your answer. Note that each arrow may contain multiple types of LSAs. In that case you need to include all types of LSAs (type 1-5) you can come with.

b) With appropriate diagrams, explain the concept of different OSPF areas. 6
c) What are the two capabilities supported by RIP 2 but not RIP 1? 2
d) Look at the following topology. All routers are running OSPFv2 protocol. 6
   Calculate the number of adjacencies (between neighbors) when:
   i. there is no DR or BDR in the topology
   ii. only DR is present but there is no BDR
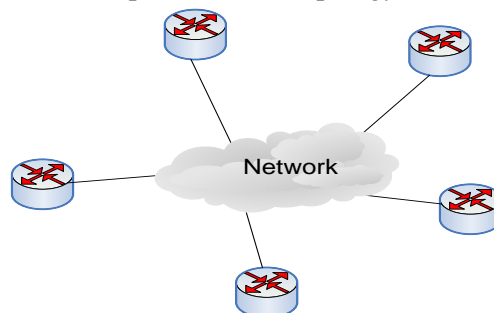   iii. both DR and BDR are present in the topology

Fig 4

Time: 2 hours   **Total Marks: 70**

Answer any three (3) out of the following five (5) questions. Marks are given in the right margin.

1 (a) Explain the terms *actor*, *use-case* and *system boundary*.   **[4]**

(b) Consider the normal operation of an ATM. The scenarios are like; a customer inserts the card, enters his/her PIN, enters the amount, takes the card, and takes/deposits/transfers the money. Identify the main actors and give the use-cases.   **[12]**

(c) Draw one use-case diagram of a web-based bookstore, for instance Amazon, with two different actors and two different use-cases. Both actors shall be humans and have an association to at least one use-case.   **[7.33]**

2 (a) (i) What aspects lead to the success of Agile methods? Explain with the basis of its principles.   **[8+4+4]**
(ii) What are the problems with Agile methods?
(iii) How does Extreme Programming relate to Agile methods?

(b) Discuss the five categories of the stakeholders with respect to effective software project management.   **[7.33]**

3 (a) Give two reasons why it is a good idea to classify and separate functional requirements and non-functional requirements in a requirements specification.   **[4]**

(b) For the following description of a system, identify functional and non-functional requirement of the system: **[12]**

A user can request a quiz in the system. The system picks a set of questions from its database and composes them together to make a quiz. It rates the user's answers, and gives hints if the user requests it. In addition to users, we also have tutors who provide questions and hints. And also examiners who must certify questions to make sure they are not too trivial, and that they are sensible.

(c) Suggest two different readers of a Requirement Analysis document. Explain what they will look for in the specification.   **[7.33]**

4 (a) Draw a class diagram that represents a book which is defined by the following statement: "A book is composed of a number of parts, which in turn are composed of a number of chapters. Chapters are composed of sections." Draw the class diagram focusing only on classes and relationships. **[4]**

(b) Create a UML *activity* diagram modeling a student applying for a job that is described by the following scenario: **[12]**

The student is writing a letter that is sent to a 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 email with a response to the application. When the student is called for an interview, he may or may not get the job based on the interview. If he gets the job at this meeting, he will get a response after the 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 swim-lanes and give proper names.

(c) Draw a context diagram for the following system: **[7.33]**

A store is doing business by selling paints and hardware items. A number of reputed companies supply items to the store. New suppliers can also register with the store after providing necessary details. The customer can place an order with the shop telephonically or physically. In case items are not available, customers are informed. The details of every new customer is stored in the company's database for future reference. Regular customers are offered discounts. Additional details of daily transactions are also maintained.

5 (a) Software testing activities boil down to selecting and executing test cases. Identify three key elements of a test case. **[6]**

(b) Explain briefly the purpose of Black-Box and White-Box testing techniques. Why do we need a separate operational environment and a test environment? **[5.33]**

(c) Consider the following program segment: **[12]**
```
a = b;
if (c > 0){ a++; }
else {
      a=2*a;
      if (d <= 10){ b = 5*d; }
      else         { b = 3*d+5; }
}
e = a + b;
```
Give a control flow graph for this program fragment and give branch coverage and path coverage with node numbering of your choice.

Total Marks: 70   **Credits: 3**   **Time: 2 hours**

Answer any 03 (THREE) of the following 05 (FIVE) questions

1. a) Point out the policies adopted in ARM architecture design to address limitations of RISC architecture and to have an edge over CISC machine performance. 5.33

   b) Among the three machine language representations of ARM assembly instructions given below identify the inconsistencies (if any) and explain. [Treat each instruction individually.] 9
   i) 1010-0000-0010-0011-1100-0101-1001-0011
   ii) 1100-0101-0111-1000-1000-1010-1010-1010
   iii) 0111-0101-1000-1111-0110-1010-0101-1111

   c) Convert the following three ARM assembly data processing instructions into their corresponding machine language representations. You can take help from the Appendix (Page 3) if necessary. 9
   i) ADD r0, r1, r2
   ii) SBCLS r3, r5, r6, LSL r0
   iii) MOV r0, #&2940 (hex value)

2. a) Suppose, r3 = 0ACB, r5 = ACB5, r6 = 0035 and r0 = 0003 (all values are in hex). What will be the updated value of these registers after executing the following ARM instruction: 3.33
   SUB r3,r5,r6,LSL r0
   Also provide an explanation for your answer.

   b) Explain pre-indexed and post-indexed load operation in ARM with examples. 4

   c) How does ARM handle a long range subroutine call in THUMB mode? Can this subroutine be executed in regular ARM mode? Explain. 8

   d) Draw block diagram(s) and discuss step-by-step datapath activities in 3-stage pipeline ARM organization for the following instruction: 8
   STR r3, [r0, r4, lsl #3]

3. a) What are the similarities and differences between LEA and MOV with the OFFSET directive? 3.33

   b) Explain the purpose of the following bits in the flag register of 80386: 4
   i) IOPL   ii)O   iii)VM   iv)T

   c) Calculate accessed memory addresses for the following instructions in real mode of 80286 given that, CS = 2000H, DS = 3000H, SS = 3000H, ES = FF00H, BX = FF04H, DI = 1020H, SI = 2030H, SP = 100H, BP = 98H. 10
   You also need to mention the updated value of the registers affected by the execution of each instruction where possible.
   Note: Treat all instructions independently.
   i) MOV DX, [BX+SI]

ii) POP CX
iii) MOVSB
iv) MOV ES:[DI], CX
v) ADD AX, [BP+2]

d) Consider the following 80386 descriptor. Find starting and ending location indicated   6
by it when
i) granularity bit = 0
ii)granularity bit = 1

1 0 1 0 1 1 0 0	G	D	L	AV	1 1 0 0	Access Rights	0 0 0 0 1 1 1 1
0 1 0 1 0 0 0 0 1 0 1 0 1 1 1 1						0 0 0 0 1 0 1 0 0 0 1 1 0 0 0 0	

4 a) Explain pipelined memory access of 80386 showing transition among different BUS   8
states.

b) Briefly describe the near and far procedure calls of the 8086 microprocessor.   8

c) What are the benefits and disadvantages of using registers for parameter passing?   4

d) Describe the operation of INTO instruction.   3.33

5 a) Find the addressing modes for the following operations.   8
i) PUSHF   ii) MOV [BP+2], CX   iii) JNZ YZ   iv) OUT 03H

b) Give an example of signed overflow.   3

c) Which flags are used for the following program control instructions?   4
i) JNE   ii) SBB   iii) STC   iv) CMPSB

d) What are the restrictions of MOV and XCHG instructions?   2.33

e) Explain thread mode and handler mode of Cortex-M3. How does Cortex-M3 achieve   6
low interrupt latency and efficient processing of late arriving interrupts?

Appendix	

Opcode [24:21)	Mnemonic
0000	AND
0001	EOR
0010	SUB
0011	RSB
0100	ADD
0101	ADC
0110	SBC
0111	RSC
1000	TST
1001	TEQ
1010	CMP
1011	CMN
1100	ORR
1101	MOV
1110	BIC
1111	MVN

Opcode [31:28]	Mnemonic extension
0000	EQ
0001	NE
0010	CS/HS
0011	CC/LO
0100	Ml
0101	PL
0110	VS
0111	VC
1000	HI
1001	LS
1010	GE
1011	LT
1100	GT
1101	LE-
1110	AL
1111	NV

Figure A1: ARM DPI Opcodes

Figure A2: ARM Condition Codes

University of Dhaka
Department of Computer Science and Engineering
3rd Year 1st Semester B.Sc. Final Examination, 2020
CSE – 3104: Database Management System – II

Total Marks: 70   Time: 2 Hours

Answer any 3 (Three) of the following Questions

1. a) Explain the importance of RAID with respect to 'Reliability via Redundancy' and 'Performance via Parallelism'.   6

    b) Make choice, by mentioning causes, between RAID level 1 (Mirrored Disks with Block Stripping) and RAID level 5 (Block-Interleaved Distributed Parity).   5.33

    c) Suppose you are a database designer. You know certain join operation of some relations (say *customer*, *order* and *order_detail*) will be executed very frequently. What type of file organization might become more efficient than others? What might be the problem?   6

    d) Consider the following relation with 'ID' as candidate key. The relation is sorted on attribute 'Age'. Draw two secondary indices on candidate key 'ID' and non-candidate key 'Gender' (M = Male, F = Female and C =Common).   6

ID	Name	Gender	Age
09	Rahim	M	30
07	Karim	M	32
10	Salma	F	32
04	Shimul	F	35
08	Rafi	C	37
06	Shihab	M	48
01	Rifat	F	48
05	Khokon	M	48
02	Fuad	M	53
03	Naser	C	60

2. a) Suppose we keep databases having dense primary indices and sparse secondary indices. How do you define this indices – good or bad and why?   3.33

b) Consider the following B+ - tree.   10
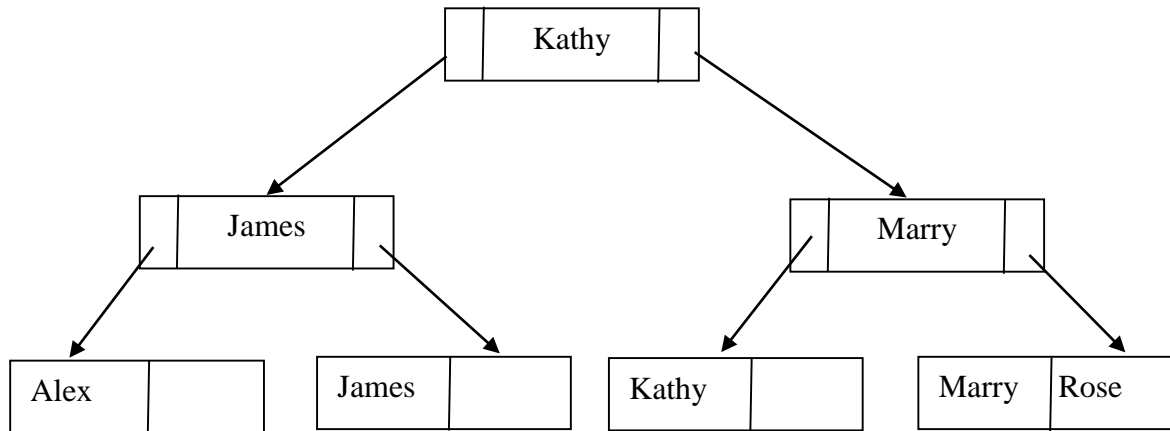
What would the tree look like after the following sequence of operations:
insert 'Bob', insert 'Marry', and delete 'Kathy'?

c) Consider a bucket split that occurs whenever an overflow page is created. Let $h_0(x)$ 10
takes the rightmost 3 bits of key x as the hash value, and $h_1(x)$ takes the rightmost 2
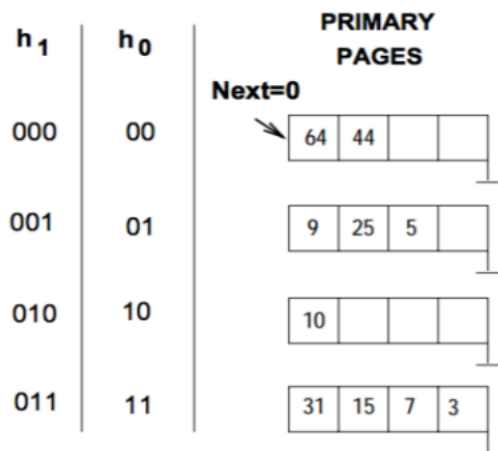bits of key x as the hash value.

Figure-1: Hashing

Starting from the above hash table, plot the final hash table after inserting 17, 25, and
30. Remember to indicate the new hash function (if any), and to update the 'Next'
pointer, if needed.

3. a) What are the steps involved in generating the query evaluation plan for an SQL   5
expression? Briefly discuss with diagrams.

b) 'Although indices are used for faster accesses to database, sometimes linear search could be a better choice' — explain.   4

c) Find the query cost of block nested-loop join for worst and best case. Is indexed nested-loop join a better choice than block nested-loop join? Explain.   5

d) Optimizers also use heuristics along with cost based optimization. How do heuristics help in this regard?   4.33

e) What is the problem with 'materialization' approach of evaluation of an expression? If 'pipelining' approach is an alternative, what are the limitations of this approach?   5

4. a) State the pros and cons of data replication in distributed database systems.   3.33

b) "Functional dependency (FD) has an impact on data fragmentation" — give your opinion with an explanation.   10

Consider the following 'Invoice' relation. Show horizontal and vertical fragmentations of this relation (note: you have to define its FDs before performing fragmentation).

Relation: INVOICE
Invoice_number
Product_lno
Sale_date
Product_label
Product_price
Vendor_code
Product_quantity
Product_price

c) Consider a distributed DBMS with four sites. In site 1, there is 'Employee' relation, in site 2, there is 'Department' relation and in site 3, there is 'Salary' relation.   10

In site 1, Employee:

ID	Name	DOB	Address	DeptNo

Here, there are 200 records where each record is 100 bytes long. *ID* is 10 bytes long, *DeptNo* is 5 bytes long and *Name* is 10 bytes long.

In site 2, Department:

DeptNo	DeptName	Manager_ID

Here, there are 10 records with each record is 30 bytes long. *DeptNo* is 5 bytes long, DeptName is 15 bytes long and Manager_ID is 10 bytes long.

In site 3, Salary:

DeptNo	ID	Salary

Here, there are 200 records with each record is 20 bytes long. *DeptNo* is 5 bytes long, *ID* is 10 bytes long and *Salary* is 5 bytes.

Suppose a user submits a query to site 4 in order to extract all manager names and their salaries. The result of this query will have 10 tuples if each department has one manager. Suppose each result tuple is 15 bytes long. Find an optimal way to execute this query so that the total data transfer be minimum.

5. a) Differentiate between 'Transaction Processing System' and 'Decision Support System'. 4
   b) With the help of an example define 'Support' and 'Confidence' of association rules. 4
   c) What are the motivations of using object based databases? 5
   d) Consider the following example of a non 1-NF relation *books*: 5.33

title	author_array	publisher	keyword_set
		(name, branch)	
Compilers	[Smith, Jones]	(McGraw-Hill, NewYork)	{parsing, analysis}
Networks	[Jones, Frick]	(Oxford, London)	{Internet, Web}

How are array [*author_array*] and multiset-valued [*keyword_set*] attribute declared in object based database? How can you create the table *books* using object-based approach?
   e) What are the advantages and drawbacks of persistent programming language? 5

Time: 2 hours   **Total Marks: 70**

Answer any three (3) out of the following five (5) questions. Marks are given in the right margin.

1 (a)   Find a vector perpendicular to the plane that passes through the points   **[5]**
P(1, 4, 6), Q(2, 5, 1) and R(1, 1, 1).

(b)   Find the scalar and vector projections of: **b** = ‹1, 1, 2› onto **a** = ‹−2 , 3, 1›.   **[7]**

(c)   What conditions must be satisfied by a subset of a vector space to be a subspace?   **[3.33]**

(d)   Find the Kernel of the following linear transformation: **[5]**

$$T(\mathbf{x}) = A\mathbf{x} = \begin{bmatrix} 1 & -1 & -2 \\ -1 & 2 & 3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} \quad (T : R^3 \rightarrow R^2)$$

(e)   Let $T: R^5 \rightarrow R^7$ be a linear transformation. Find the dimension of the kernel of T when   **[3]**
the dimension of the range is 2.

2 (a)   Let $S = \{v_1, v_2, ..., v_n\}$ be a set of vectors in vector space V. What are the conditions   **[2+3]**
which make S a basis for V? What do you mean by the standard basis? Give an example.

(b)   Let $T: R^5 \rightarrow R^4$ be defined by $T(\mathbf{x}) = A(\mathbf{x})$, where x is R^5 and   **[6.33]**

$$A = \begin{bmatrix} 1 & 2 & 0 & 1 & -1 \\ 2 & 1 & 3 & 1 & 0 \\ -1 & 0 & -2 & 0 & 1 \\ 0 & 0 & 0 & 2 & 8 \end{bmatrix}$$

Find a basis for the range of T.

(c)   Find the null space of A, where   **[12]**

$$A = \begin{bmatrix} 1 & 1 & 0 & 0 & 1 \\ 0 & 0 & 1 & -2 & 0 \\ 4 & 2 & 0 & 0 & 3 \\ 1 & 1 & 1 & -2 & 1 \\ 2 & 2 & 0 & 0 & 2 \\ 1 & 1 & 2 & -4 & 1 \end{bmatrix}$$

3 (a) What do you mean by a normal vector? How do you decide whether two vectors lie on the same plane? **[2+2]**

(b) Find the angle between the planes $x + y + z = 1$ and $x - 2y + 3z = 1$. Also find symmetric equations for the line of intersection L of these two planes. **[5+5]**

(c) Find the distance between the parallel planes $10x + 2y - 2z = 5$ and $5x + y - z = 1$. **[5]**

(d) Using the idea of Change of Basis, find the transition matrix from B to B' for the bases for R^2 below: **[4.33]**
$B = \{(-3, 2), (4, -2)\}$ and $B' = \{(-1, 2), (2, -2)\}$.

4 (a) Find the eigenvalues and corresponding eigenvectors of **[5]**
$$A = \begin{bmatrix} 2 & 1 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 2 \end{bmatrix}$$

(b) Explain the concept of Tangent Planes with an example. Find the tangent plane to the elliptic paraboloid $z = 2z^2 + y^2$ at the point $(1, 1, 3)$. **[3+4]**

(c) Find the directional derivative of the function $f(x, y) = x^2y^3 - 4y$ at the point $(2,-1)$ in the direction of the vector $v = 2i + 5j$. **[7]**

(d) What is the second derivative test? Why is it used? **[4.33]**

5 (a) A rectangular box without a lid is to be made from $12m^2$ of cardboard. Find the maximum volume of such a box. **[6]**

(b) Compute the following double integral: **[7.33]**
$$\iint_R 6xy^2 \, dA, \ R = [2, 4] \times [1, 2]$$

(c) Find the maximum and minimum values of $f(x,y,z) = xyz$ subject to the constraint $x + y + z = 1$. Assume that $x, y, z \geq 0$. **[10]**