Solution 1 (a) Prob of transmitting a frame by B = p

" " " " " " BA = 2p

$$\text{Utilization} = (p)(1-2p) + (2p)(1-p)/1$$

$$= 3p - 4p^2$$

Max utilization equate to zero

$$\frac{d}{dp}\, 3p - 4p^2 = 0$$

$$3 - 8p = 0$$

$$p = 3/8.$$

[$1\frac{1}{2}$ marks]

$$\therefore \text{Max utilization} = 3(3/8) - 4(3/8)^2$$

$$= 9/8 - 9/16$$

$$= 0.5625$$

[$\frac{1}{2}$ Marks]

(b) Frame Tx time = 1200 bits/10 sec

$$= 120 \text{ bps}$$

Throughput of channel = Utilization x B/W

$$N \times 120 \text{ bps} = 0.5625 \times 1 \text{ Mbps}$$

$$= \frac{0.5625 \times 10^6}{120}$$

$$= \frac{5625 \times 10\cancel{0}}{12\cancel{0}}$$

$$= 4687.5$$

$$\simeq 4687 \text{ nodes}$$

4688 (is ok as well)

[2 Marks]

if logic is right but part (a) values are wrong then award (1 Mark)

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②

(c)

```
          11111
1011 ) 11011001,000
       1011
       01101
        1011
        01100
         1011
         01110
          1011
          01011
           1011
           0000
```

$G = x^3 + x + 1$ (3 2 1 0)

$= 1011$

$G - 1 = 3$

1½ marks if partially done

Sent msg = 11011001000

3 Marks

(d)

	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	d_{10}	d_9	d_8	d_7	d_6	d_5	r_4	d_4	d_3	d_2	r_3	d_1	r_2	r_1

$2^r \geq r + m + 1$

data = 1101100110

$2^4 \geq 4 + 10 + 1$

$16 \geq 15$

$\therefore r = 4$

14	13	12	11	10	9	8	7	6	5	4	3	2	1
1	1	0	1	1	0	0	0	1	1	1	0	1	1

7^{th} bit is toggled

14	13	12	11	10	9	8	7	6	5	4	3	2	1
1	1	0	1	1	0	0	$\cancel{0}$ 1	1	1	1	0	1	1

		computed	sent
$r_1 =$	0, 1, 1, 0, 1, 1 =	0	1
$r_2 =$	0, 1, 1, 1, 1 =	0	1
$r_3 =$	1, 1, 1, 0, 1 =	0	1
$r_4 =$	0, 1, 1, 0, 1, 1 =	0	0

Common bit position in r_1, r_2, r_3 is 7 ∴ 7^{th} bit is changed.

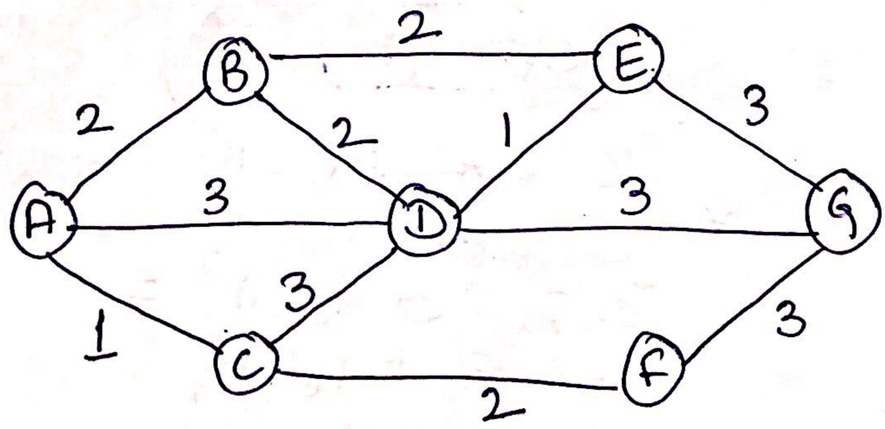
2 Marks
[2 Marks if partially done]

Solution 2:- (a) Atleast two differences between LS Routing & DV routing

- Centralized Vs decentralized
- Difficult to converge (DV) vs costly maintainence of tables (LS)

[$1\frac{1}{2}$ to most
2 Max]

(b)



(4).

(b)

A	A	B	C	D	E	F	G
A	0	2	1	3	∞	∞	∞
B	2	0	∞	2	2	∞	∞
C	1	∞	0	3	1	2	∞
D	3	2	3	0	1	∞	3

4 marks

(C) D's stable table before link break

D	A	B	C	D	E	F	G
~~B~~A	0	2	1	3	4	3	6
~~E~~B	2	0	3	2	2	5	5
C	1	3	0	3	4	2	5
D	3	2	3	0	~~3~~1	5	3
E	4	2	4	1	0	6	3
G	6	5	5	3	3	3	0

As link AD breaks, rcvd vectors are

	A	B	C	D	E	F	G
B	7	0	3	6	2	7	8
C	6	4	0	7	3	5	8
E	3	7	5	4	0	6	5
G	2	4	5	3	6	7	0

$$d_x(y) = \min_v \left(c(x,v) + d_v(y) \right)$$

$$d_D(A) = \min_v \begin{cases} c(D,A) + d_A(A) \\ c(D,B) + d_B(A) \\ c(D,C) + d_C(A) \\ c(D,E) + d_E(A) \\ c(D,G) + d_G(A) \end{cases} = \begin{cases} \cancel{3}\,\infty + 0 \\ 2 + 7 \\ 3 + 6 \\ 1 + 3 \\ 3 + 2 \end{cases} = 4$$

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$$d_D(B) = \min \begin{bmatrix} c(D,B) + d_B(B) \\ c(D,A) + d_A(B) \\ c(D,C) + d_C(B) \\ c(D,E) + d_E(B) \\ c(D,G) + d_G(B) \end{bmatrix} = \min \begin{bmatrix} 2+0 \\ \infty + \infty \\ 3+4 \\ 1+7 \\ 3+4 \end{bmatrix} = 2_{(D)}$$

$$d_D(C) = \min \begin{bmatrix} c(D,C) + d_C(C) \\ c(D,A) + d_A(C) \\ c(D,B) + d_B(C) \\ c(D,E) + d_E(C) \\ c(D,G) + d_G(C) \end{bmatrix} = \min \begin{bmatrix} 3+0 \\ \infty \\ 2+3 \\ 1+5 \\ 3+5 \end{bmatrix} = 3_D$$

$$d_D(E) = \min \begin{bmatrix} c(D,E) + d_E(E) \\ c(D,A) + d_A(E) \\ c(D,B) + d_B(E) \\ c(D,C) + d_C(E) \\ c(D,G) + d_G(E) \end{bmatrix} = \min \begin{bmatrix} 1+0 \\ \infty \\ 2+2 \\ 3+3 \\ 3+6 \end{bmatrix} = 1_D$$

$$d_D(G) = \min \begin{bmatrix} c(D,G) + d_G(G) \\ c(D,A) + d_A(G) \\ c(D,B) + d_B(G) \\ c(D,C) + d_C(G) \\ c(D,E) + d_E(G) \end{bmatrix} = \min \begin{bmatrix} 3+0 \\ \infty \\ 2+8 \\ 3+8 \\ 1+5 \end{bmatrix} = 3_D.$$

$d_D(F)$ = PTO

$$\text{D's new vector} = D\begin{array}{c} \begin{array}{ccccccc} A & B & C & D & E & F & G \end{array} \\ \left(\begin{array}{ccccccc} 4 & 2 & 3 & 0 & 1 & 5 & 3 \end{array}\right) \end{array}$$

$$d_D(F) = \min \begin{bmatrix} C(D,F) + d_F(F) \\ C(D,A) + d_A(F) \\ C(D,B) + d_B(F) \\ C(D,C) + d_C(F) \\ C(D,E) + d_E(F) \\ C(D,G) + d_G(F) \end{bmatrix} = \min \begin{bmatrix} 5+0 \text{ (old value)} \\ \infty \\ 2+7 \\ 3+5 \\ 1+6 \\ 3+7 \end{bmatrix} = 5$$

(2 marks if partially done) 4 marks

Solution 3:- Prop delay $= 12.5$ ms

$K_A = 0$, $K_B = 1$.

Jamming Signal 48 bit times

IFS = 96 bit times

frame size = 1000 bits

Link Rate = 10 Mbps = 10×10^6 bps

$$1 \text{ bit time} = \frac{1}{10 \times 10^6}$$

$$12.5\text{ms} = \frac{12.5 \times 10^3}{10 \times 10^6} = 0.00125$$

time	A	B
t=0	A transmits	B transmit
t=0.00125/2	Collision occurs	collision occurs
t=0.00125	coll^n signal reaches A	coll^n signal reaches B
0.00125+48 = 48.00125	Jamming signal	Jamming signal
48.00125 + 0.00125 = 48.00250	B's Jamming signal's last bit arrives at A $K_A = 0$, No wait for A	A's Jamming signal's last bit arrives at B $K_B = 1$, B waits 512 bit times = 48.00250 + 512 = 560.00250
48.00250 + 96 = 144.00250	A checks IFS time of 96 bit times	
144.00250 + .00125 = 144.00375	A transmits A's 1st bit would reach B at.	4 marks (if IFS not taken) 5 full marks 2½ (if partially done)

Solution 4 :- Selective Repeat

N = 4

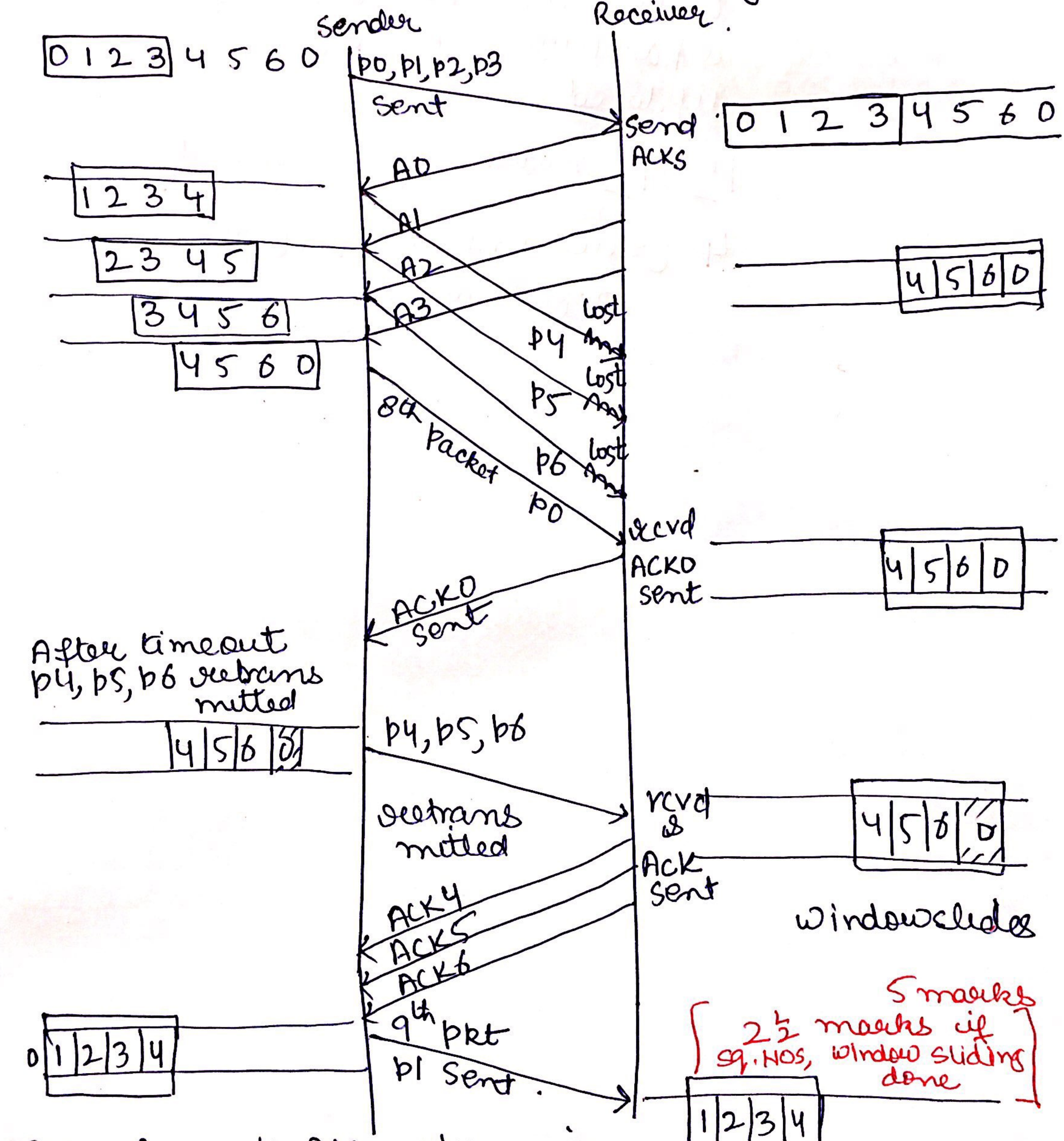
Sq. NOS 0, 1, 2, 3, 4, 5, 6

p4, p5, p6 are lost

New p0 recvd successfully

Total 9 pkts

ACKS recvd successfully



5 marks

[2½ marks if sq. NOS, window sliding done]

Protocol doesn't fail under given circumstances.

Solution 5:- DHCP description showing/ explaining how a new node gets address

ARP description showing/ explaining how MAC address for a node is traced and ARP table of a particular node is updated.

$1\frac{1}{2} + 1\frac{1}{2}$ marks [to majority]

4 [few, only if properly differentiated].