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Subject : Discreate Structure

Assignment No: 02

Submitted to : Saif Ullah jan

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Question = 1

Recurrence Relation =>

A recurrence relation for the sequence $\{a_n\}$ is an equation that express a_n in terms of one or more of the Previous of the sequence, namely, $a_0, a_1, \ldots, a_{n-1}$, for all integer n with $n \geq n_0$ is a nonegative integer. A sequence is called a solution of a recurrence relation if its terms satisfy the recurrence relation.

Example => Let $\{a_n\}$ be a sequence the satisfies the recurrence relation relation $a_n = a_{n-1} + 3$ for $n = 1, 2, 3, \ldots$ and suppose that $a_0 = 2$. What are a_1, a_2 and a_3.

we see recurrence relation

$a_1 = a_0 + 3 = 2 + 3 = 5$

then $a_2 = 5 + 3$ $\quad a_3 = 8 + 3 = 11$

Using Substitution Method:

$$T(n) = \begin{Bmatrix} T(n/2) + c & \text{if } n > 1 \\ 1 & \text{if } n = 1 \end{Bmatrix}$$

$$T(n) = T(n/2) + c$$

$$T\left(\frac{n}{2}\right) = T(n/4)c + c$$

$$T\left(\frac{n}{4}\right) = T(n/8) + c$$

we now $T(n)$ = is equal to $T(n/2)+c$
and again $T(n/2)$ is equal to $T(n/4)+c$
we write

$$T(n) = T(n/2)+c$$

we write

$$T(n) = T(n/4)+c+c$$

$$= T(n/2^2) + 2c$$

then

$$= T(n/2^3) + 3c$$

then

$$= T(n/2^4) + 4c$$

$$\vdots$$

$$k$$

$T(n/2^k) + kc$ $\quad\therefore\ n = 2^k$

we log both side

$T(n/n) + kc$ $\quad \log n = \log 2^k$

$= T(1) + kc$ $\quad n = k \log 2$

$= 1 + \log n\, c$

1 and (c) constant $\quad \boxed{= O(\log_2 n)} \quad$ O = order

Question : 2

Premises: If there was a ball game, then traveling was difficult. If they arrived on time, then traveling was not difficult. They arrived on time.

Conclusion: There was no ball game.

Determine symbolically using the rule of inference.

P: There was a ball game

q: Traveling was difficult.

r: They arrived on time.

Sol:

1→	$p \rightarrow q$	Premises
2→	$r \rightarrow \sim q$	Premises
3→	r	Premises
4→	$\sim q$	2, 3 Modus Poneus
5→	$\sim q \rightarrow \sim p$	1, ContraPositive
	$\sim p$	4, 5 Modus Poneus

Conclusion: $\sim P$ = There was no ball game

Question : 3

Premises: If Claghorn has wide support, then he'll be asked to run for the senate. If claghorn yells "Eureka" is Iowa, he will not be asked to run for the Senate. Claghorn yells "Eureka" in Iowa.

conclusion: claghorn does not have wide support.

Determine logically symbolically using rule of inference.

Sol:

P : Claghorn has wide support.

q : Claghorn is asked to run for the Senate.

r : claghorn yells "Eureka".

$P \rightarrow q$	Premises
$r \rightarrow \sim q$	Premises
r	Premises
$\sim q$	2, 3 Modus Pneus
$\sim q \rightarrow \sim P$	1 ControPositive
$\sim P$	5, 6 Modus Pneus

Conclustion $\sim P$ = Claghorn does not have wide support.

Question : 4

Pigeon hole Principal:

Consider a flock of Pigeons nestled in a set of n Pigeonhole. If there are n Pigeon, then it is Possible for all of the Pigeon to rest happily in separate Pigeonholes. However, if at least one more Pigeon arrives, making a total of more than n Pigeon, then at least one of the Pigeonhole, inevitably, will end up with more than one Pigeon.

The idea that having more Pigeons than Pigeonhole requires a Pigeonhole with more than one Pigeon is seemingly trivial, but it turns out to be important enough that it has a name.

Theorms of Pigeonhole Principal:

If more than n object are Placed into n boxes, then at least one box must Contain more than one object.

At first glance, the Pigeonhole Principle also known as Dirichlet's Principle in honor of the eponymous German mathematician might appear to be too obvious to be useful; indeed, the Power of the Principle comes from cleverly choosing the "boxes" and "object". Even though the Principle itself itself is quite simple, it is not always clear if it is useful and, if so, how. For instance, consider the following example:

Example of Pigeonhole Principle:

A box contains three Pairs of Socks colored red, blue, and white, respectively. Suppose I take out the Socks without looking at them. How many Socks must I take out to be sure that they will include a matching Pair?

If I take only 2 or 3 Socks, it is Possible that they are different. For example: they may be one red and one blue; or one red, one blue and one white. But if I take out 4 Socks, these must include a matching Pair. Here the 4 chosen Socks are the "object" and the 3 colors are the "boxes"; by PP1, it follows that at least two of the four chosen must have the Same colour and hence must be a matching Pair. Thus the minimus number of Socks to be taken out is 4.

Ans: 2 There are $26 \times 26 = 676$ different Possibleties set of two initials that can be obtained using the 26 letter A. B. C, ... Z So the number of student should be greater than 676. Thus the minimum number of student is 677.

Example 2
How many student do you need in School to guarantee that there are least 2 student who have the same first two initials?

Question : 5

The light in classroom are controlled by two switches ; one at the back and one at the front of the room. Moving either switches to the opposite Position turns the light off if they are on and on if they are off. Assume the light have been intalled so that when both switches are in down Position, the light are off.

Design a circuit to controll the switches.

Sol:

Let P and Q be switches

Let R be the right.

Let 0 represent that the switch is in the down Position and let 1 represent that the switch is in the up Position.

R=0 represent that light are off and R=1 represent that the light are on.

If both switches are in the down Position, then the light are ~~turned on~~ are off

$P = 0$ and $Q = 0$, then $R = 0$

If one of the switches is turned in the up Position, then the light are turned on.

$P = 1$ and $Q = 0$, then $R = 1$

$P = 0$ and $Q = 1$, then $R = 1$

If one of the switches was in the up Position (light are on) and the other switch is also turned into the up Position, then the light should turn off again.

$P = 1$ and $Q = 1$ then $R = 0$

Combining this information is an input/output table, we then obtain.

Input		output
P	Q	R
1	1	0
1	0	1
0	1	1
0	0	0

Boolean Expression.

Negation $\sim P$: Not P

Disjunction $P \vee Q$: P or Q

Conjunction $P \wedge Q$: P and Q

we note that the second and third row of the given input / output result in an output of 1.

The second row correspond with $P=1$ $Q=0$. If $Q=0$ then the negation has opposite value thus $\sim Q=1$. Thus we obtain $R=1$ in the first row if $P=1$ and $\sim Q=1$: or equivently if their conjunction $P\wedge\sim Q$ is equal to 1.

$$P \wedge \sim Q$$

The third row corresponds with $P=0$ and $Q=1$

If $P=0$, then the negation has the opposite value, thus $\sim Q=1$

Thus, we obtain $R=1$ in the third row if $\sim P=1$ and $\sim Q=1$ or equivelently if their conjunction

$\sim P \wedge Q$

The Boolean expression corresponding to the given table is then the disjunction of the two

Previous statement, as we either have second row or the third row when $S = 1$

$$(P \wedge \sim q) \vee (\sim P \wedge q)$$

Circuit =)

A NOT gate output the negation $\sim a$ of the input a.

An OR gate output disjunction $a \vee b$ of the input a or b.

An AND gate output the conjunction $a \wedge b$ of the input a and b.

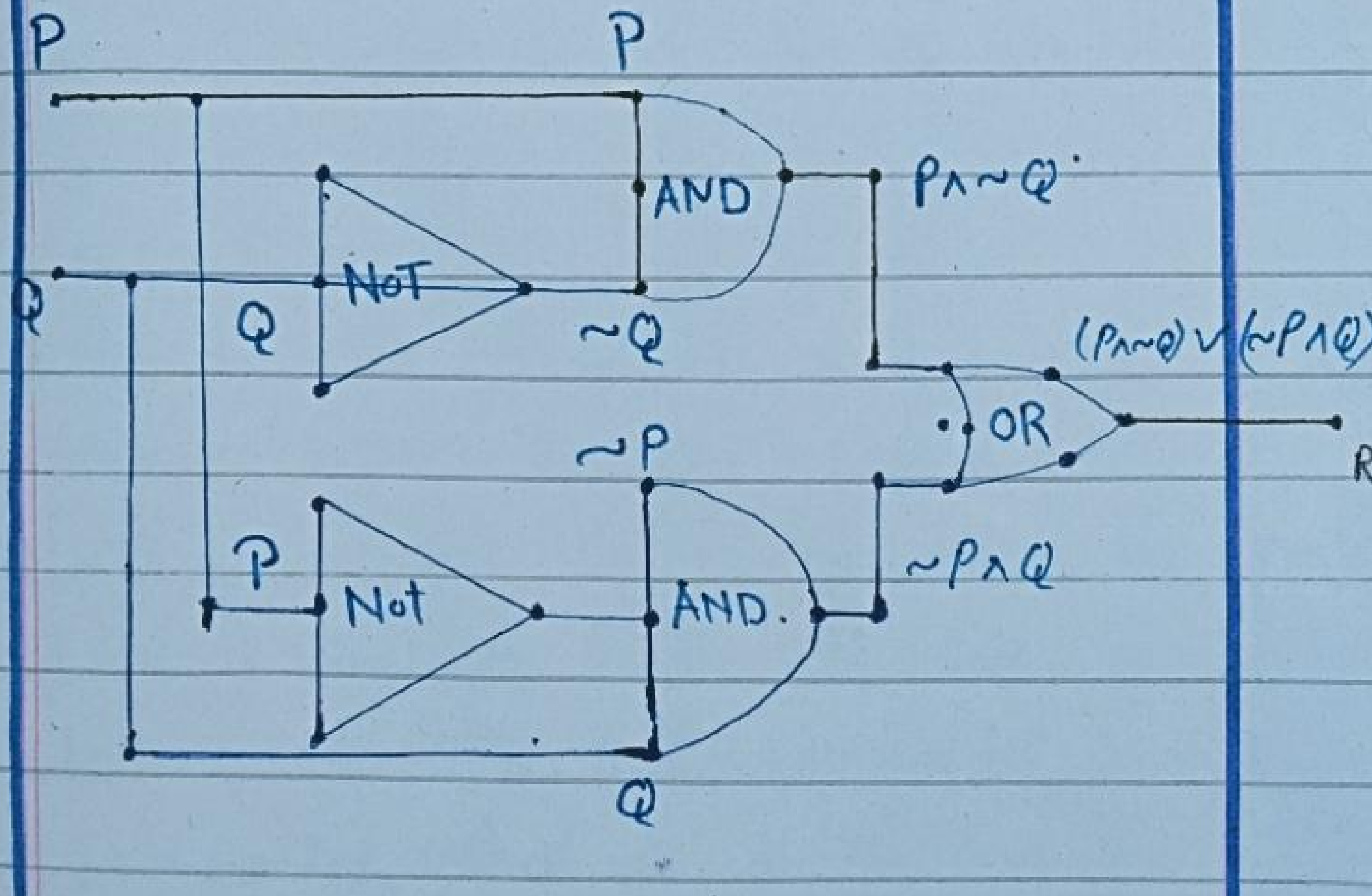
$$(P \wedge \sim Q) \vee (\sim P \wedge Q)$$

The negation will occure before the conjunction and disjunction, thus we first negate P by using a NOT gate with input P and we negate Q by using a NOT gate with input Q.

Next, the conjunctation will occure before the disjunction in $(P \wedge \sim Q) \vee (\sim P \wedge Q)$ due to the two Pair of brackets. we then need to use an AND gate with input P and $\sim Q$ to form $P \wedge \sim Q$.

while we use an AND gate with input $\sim P$ and Q to form $\sim P \wedge Q$.

Finally, we need to take the disjuncuction of $P \wedge \sim Q$ and $\sim P \wedge Q$ (output AND gate) by using an OR gate.



Design circuit Draw

Result = $(P \wedge \sim Q) \vee (\sim P \wedge Q)$

Question : 6

An alarm system has three different control panels in three different location. To enable the system, switches in at least two of the panels must be in the on position. If fewer than two are in the on the position, the system is disabled. Design a circuit to control switches.

Sol:

Let P, Q and R be the three control panels. Let S be the system.

Let 0 represent that the switch in the control panel is in the off position and let 1 represent that the switch in the control panel is in the on position. S = 0 represent that the system is disabled and S = 1 represent that the system is disabled.

If two or three of the control panels have the switches in the position, then the system is enable.

$P = 0$ and $Q = 1$ and $R = 1$, then $S = 1$
$P = 1$ and $Q = 0$ and $R = 1$, then $S = 1$
$P = 1$ and $Q = 1$ and $R = 0$, then $S = 1$
$P = 1$ and $Q = 1$ and $R = 1$, then $S = 1$

If one or more of the control panel have the switch in the on position, then the system is disable.

$P = 1$ and $Q = 0$ and $R = 0$, then $S = 0$
$P = 0$ and $Q = 1$ and $R = 0$, then $S = 0$
$P = 0$ and $Q = 0$ and $R = 1$, then $S = 0$
$P = 0$ and $Q = 0$ and $R = 1$, then $S = 0$

Combining this information in an input/output. table, we obtain

input			output
P	Q	R	S
1	1	1	1
1	1	0	1
1	0	1	1
1	0	0	0
0	1	1	1
0	1	0	0
0	0	1	0
0	0	0	0

Boolean Expression:

Negation $\sim P$: not P

Disjunction $P \vee q$: P or q

Conjunction $P \wedge q$: P and q

If two of the three control panels have the switches in the position. (S = 1) then either $P \wedge Q$, $P \wedge R$ or $Q \wedge R$ is equal to 1 (or all three are true at the same time when all three control panels have the swithes in the on position). The Boolean expression is then the disjunction of the these three statement.

$$(P \wedge Q) \vee (Q \wedge R) \vee (P \wedge R)$$

note: You ~~should~~ could also use each row of the table to represent one the term in the disjunction $(P \wedge Q) \vee (P \wedge Q \wedge \sim R) \vee (P \wedge \sim Q \wedge R) \vee (\sim P \wedge Q \wedge R)$, but this will result in a match larger and more complex circuit.

circuit

A NOT gate output the negation $\sim a$ of input a.

An OR gate output the disjunction $a \vee b$ of the input a or b.

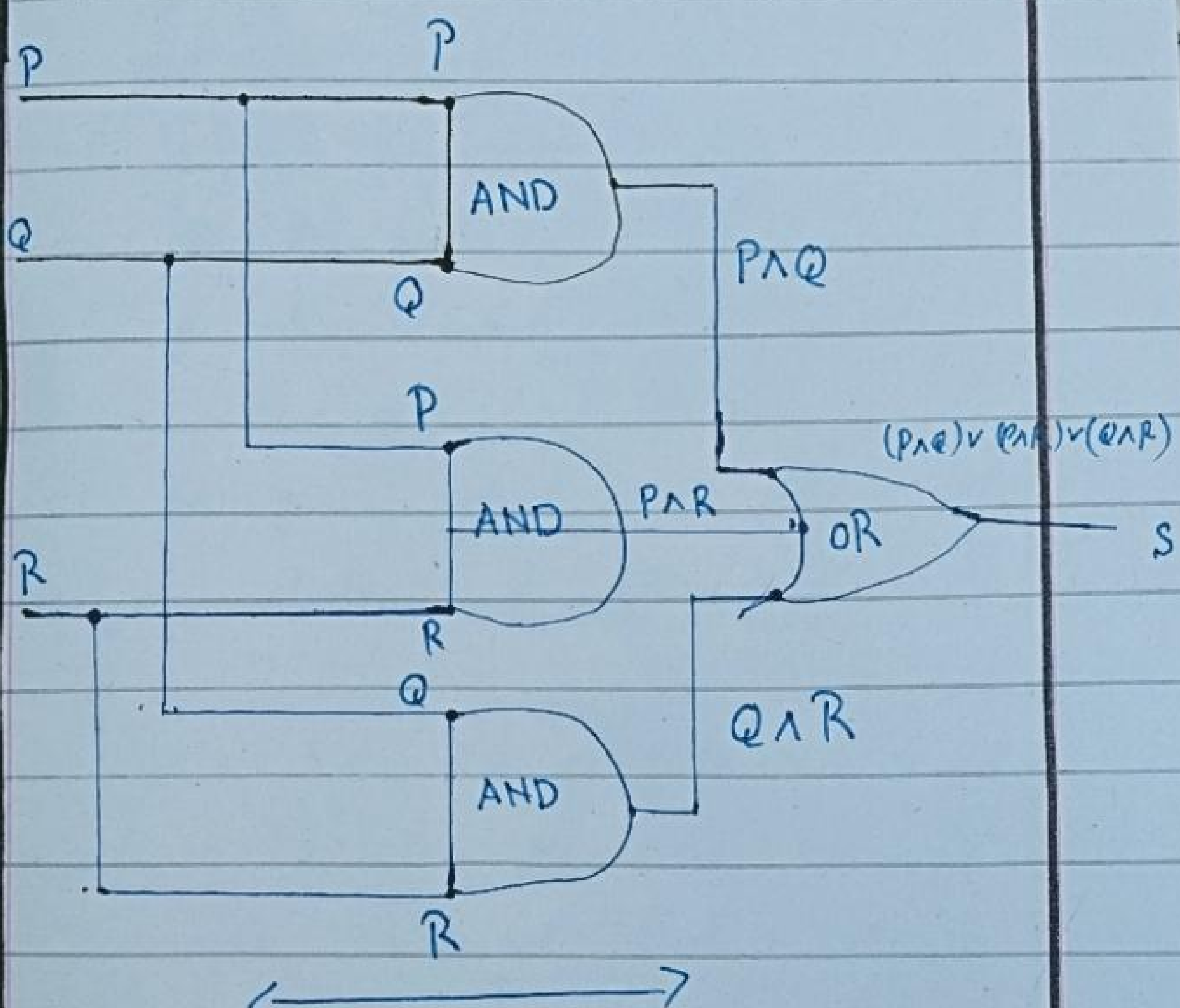
An AND gate output the conjunction $a \wedge b$ of the input a and b.

$$(P \wedge \sim Q) \vee (\sim P \wedge Q)$$

The negation will occure before the conjunction and disjunction, thus we first negate P by using a Not gate with input P and we negate Q by using a not gate with input Q.

Next, the conjunction will occure before the disjunction in $(P \wedge \sim Q) \vee (\sim P \wedge Q)$ due to the two pair of brackets. we then need used an AND gate with input P and $\sim Q$ to form $P \wedge \sim Q$. while we use an AND gate with input $\sim P$ and Q to form $\sim P \wedge Q$.

Finally, we need to take the disjunction of $P \wedge \sim Q$ and $\sim P \wedge Q$ (output AND gate) by using an OR gate.



Design cricuit

$$(P \wedge Q) \vee (P \wedge R) \vee (Q \wedge R)$$

Question 7

Given the output signal for the circuit.

(A) Answer

A Not gate change the input from a 0 to 1 or form a 1 to a 0.

An OR gate output a 1 if at least one of the input is a 1 else it output 0.

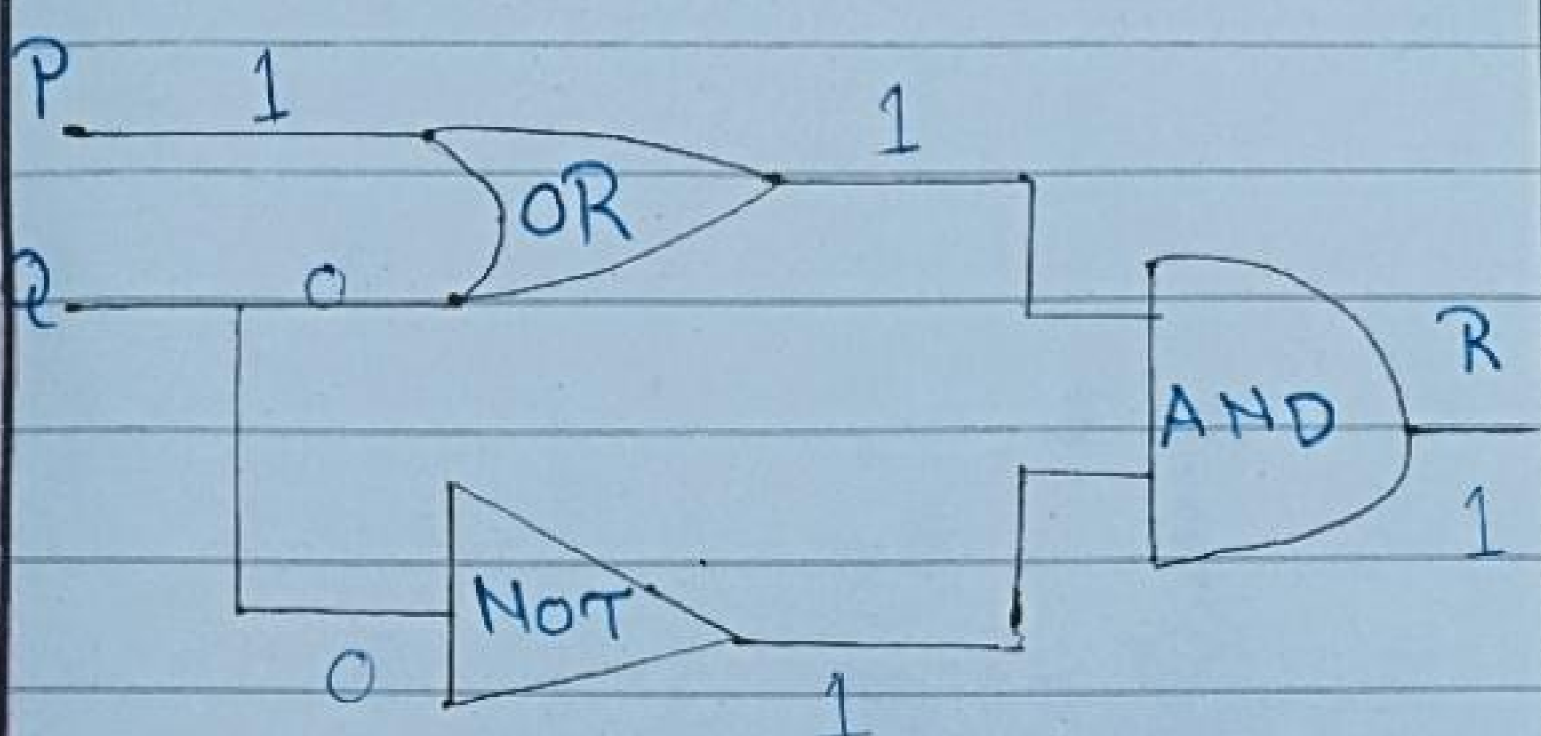
An AND gate output a 1 if both input are a 1 else it output 0.

$P = 1 \qquad Q = 0$

we note that the OR gate receive on input of 1 from P and an input of from q. since at least on of the input is a 1. The OR gate will be output a 1.

we note that the 'not gate' receive on input of 0 (from q) a thus the not gate output a 1.

Finally, we than note that the AND gate receive on input of 1 from the OR gate and an input 1 from the not gate. As both input are a 1, the AND gate will output a 1 as well thus output Signal is R = 1.



Input		Output
P	Q	R
1	0	0
1	1	1
0	0	0
0	1	0

(B) Answer $Q = 7$

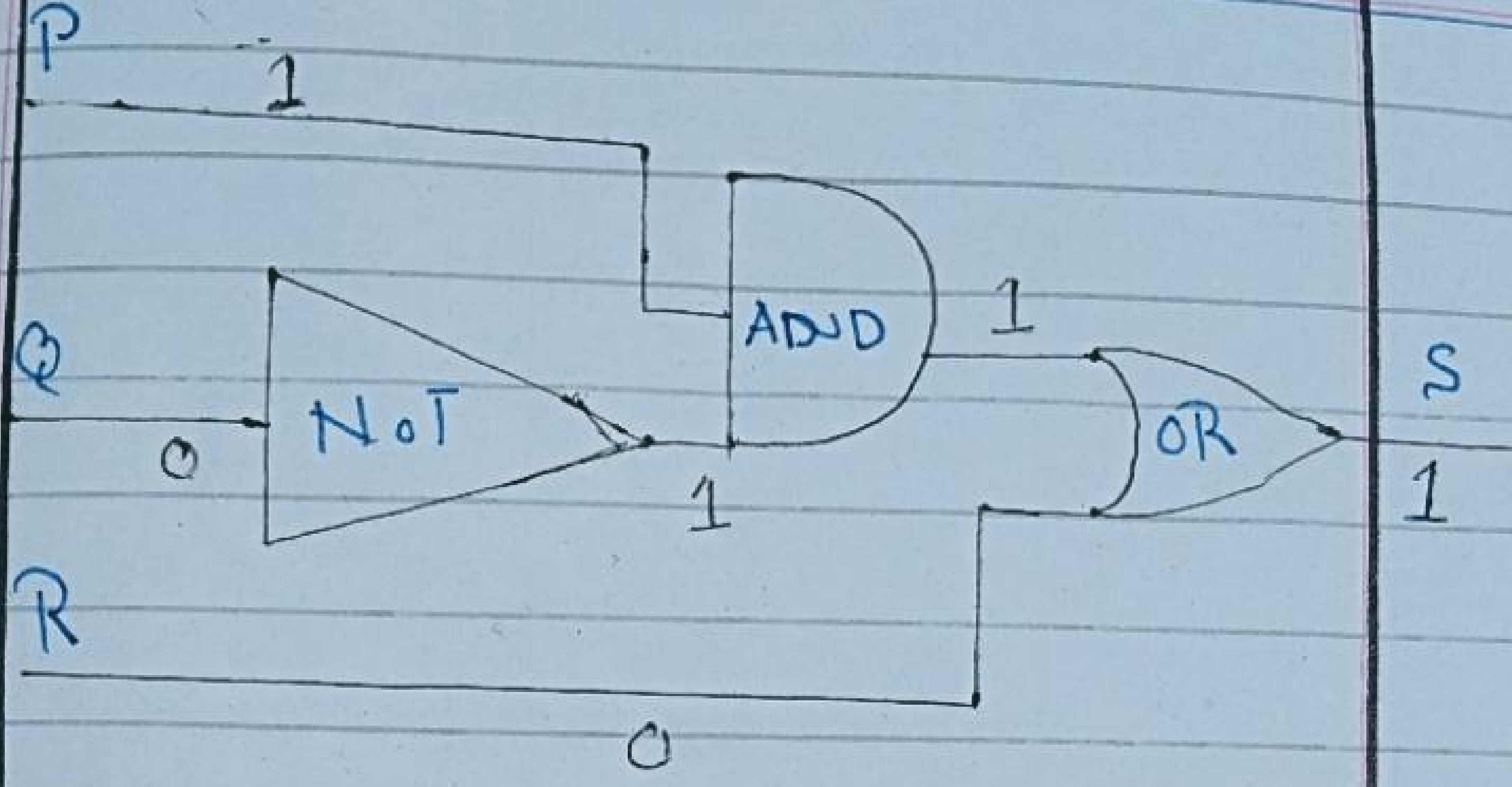
input signal $P = 1$ $Q = 0$ $R = 0$

A 'NOT' gate chang input from 0 to 1 or 1 to 0. An 'OR gate' output 1 if at least one of input 1.

A AND gate' output 1 if both input same. $P = 1$ $Q = 0$, $R = 0$

we note that not gate received on input 0 (from Q). Thus the not gate is output 1. we note that AND gate receiven on input 1 from (P) and input of 1 from Q. Since both input are 1 is output 1. lastly, we note that OR gate receive on input of 1 from the AND gate and on input of 0 from R. As at least one of the input is 1 the OR gate will output 1 as well thus output is $S = 1$

similarly, we can deire the output of each gate for every Possible input P, Q, and R.



P	Q	R	output Not gat	output AND	output OR
1	1	1	0	0	1
1	1	0	0	0	0
1	0	1	1	1	1
1	0	0	1	1	1
0	1	1	0	0	1
0	1	0	0	0	0
0	0	1	1	0	1
0	0	0	1	0	0

Input			Output
P	Q	R	S
1	1	1	1
1	1	0	0
1	0	1	1
1	0	0	1
0	1	1	1
0	1	0	0
0	0	1	1
0	0	0	0

(C) Q= 7 Answer

input signal P=0, Q=0, R=0

A 'Not gate' chang the input from 1 to 0 or 0 to 1. An 'OR' gate output 1 if at least one of them 1.

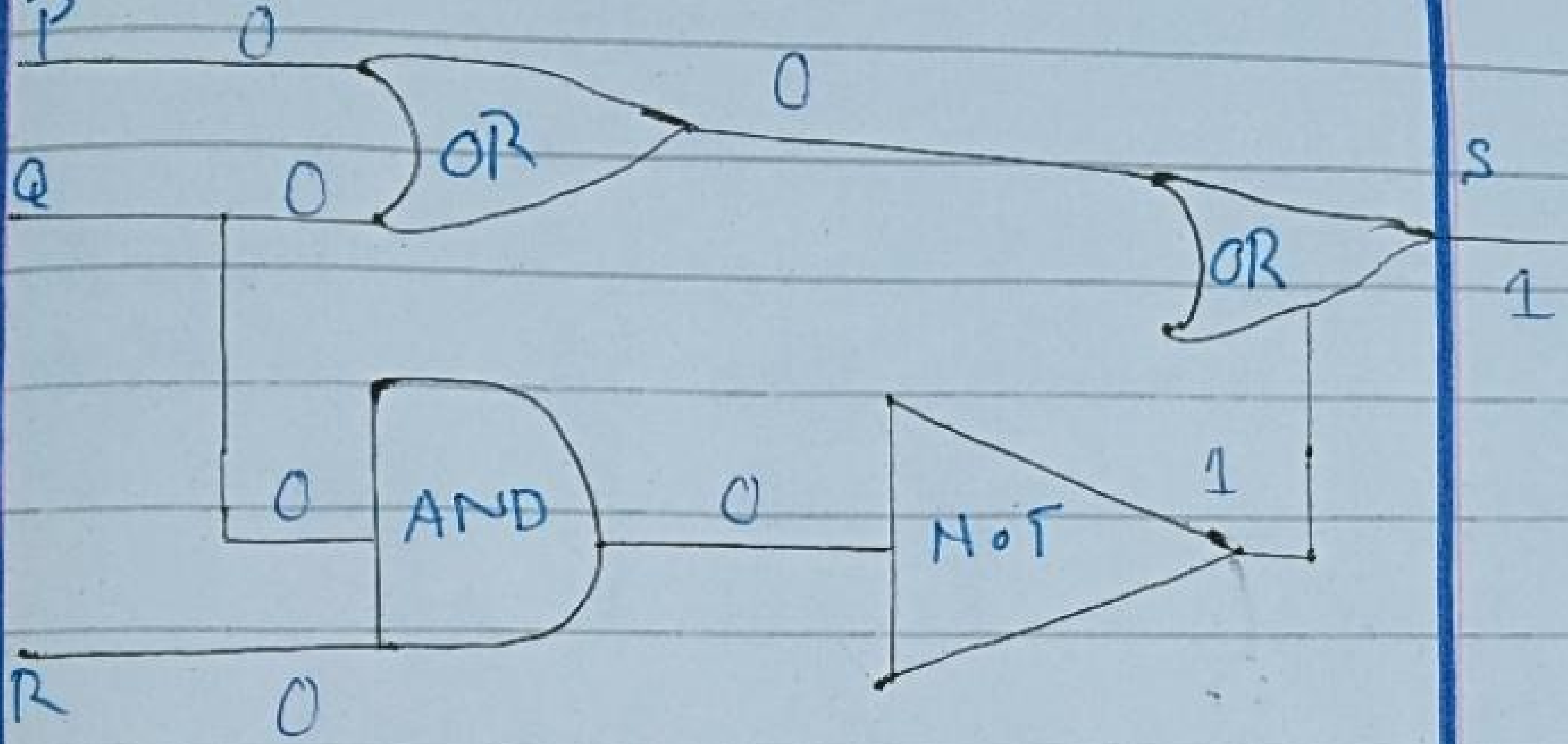
An 'AND' gate output 1 if both input is 1.

we note that the left most OR gate receive on input 0 (from P) and on input of 0 (from Q). Since at least one of the input is a 0. the OR gate will output 0.

we note that gate the AND gate receive an input of 0 from Q and on input 0 (from R.) Since both input are 0. AND gate will out put 0.

we then note that the NOT gate receive an input of 0 from the AND gate thus the not gate will output 1.

Lastly, we then note that the right most OR gate receive on input of 0 from the left most OR gate on input of from the NOT gate. As at least one of the OR gate will output 1 as well and thus that output signal $S = 1$



Input			Output
P	Q	R	S
1	1	1	1
1	1	0	1
1	0	1	1
1	0	0	1
0	1	1	1
0	1	0	1
0	0	1	1
0	0	0	1

Question 8 Answer

$A = \{0, 1, 2, 3\}$

A relation R on a set A is reflexive if $(a, a) \in R$ for every element $a \in R$

A relation R on a set A is symmetri if $(b, a) \in R$ whenever $(a, b) \in R$

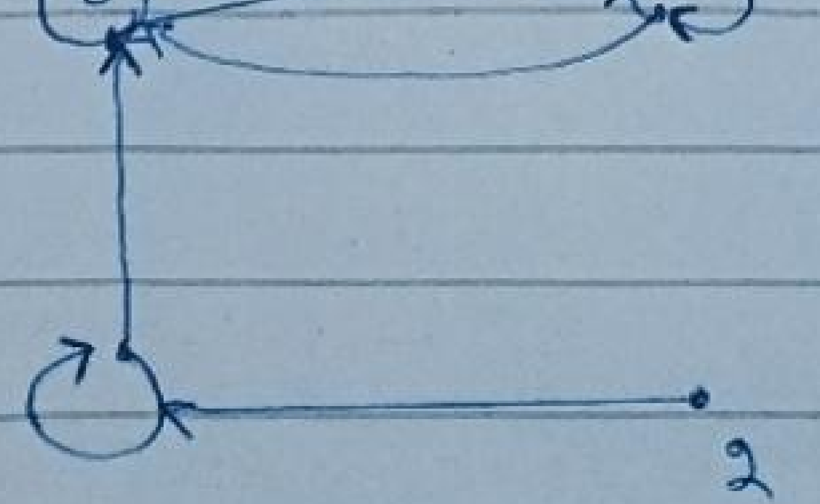
A relation R on a set A is transitive if $(a, b) \in R$ and $(b, c) \in R$ implies $(a, c) \in R$.

$$A = \{0, 1, 2, 3\}$$

$R_1 = \{(0,0), (0,1), (0,3), (1,1)(1,2)(2,3)(3,3)\}$

(a) Directed GraPh ⇒

we note that $a \in A$ contain 4 element and thus we will draw 4 Point. we label these Point (0, 1, 2, 3) which are the element of A. For every element $(x, y) \in R$ with $x \neq y$, we draw an allow from x to y.



(B) The relation R_1 is reflexise if $(a,a) \in R_1$ for every Point $a \in A$.

Since $A = \{0, 1, 2, 3\}$. R_1 is reflexise if it contain $(0,0)$, $(1,1)$, $(2,2)$, $3,3)$

we note that R_1 does not contain $(2,2)$ and thus R_1 is not reflenive. R_1 is not reflexive.

(C) The relation R_1 on a set A is symmetric if $(b,a) \in R_1$ whenever $(a,b) \in R_1$

we note that $(0,3) \in R_1$ while $(3,0) \notin R_1$ thus R_1 is not symmetric.

R_1 is not Reflexive.

D) The relation R_1 on a set is transitive if $(a,b) \in R_1$ and $(b,c) \in R_1$ implies $(a,c) \in R_1$.

we note that $(1,0) \in R_1$ and $(0,3) \in R_1$, while $(1,3) \notin R_1$ and thus R_1 is not transitive.

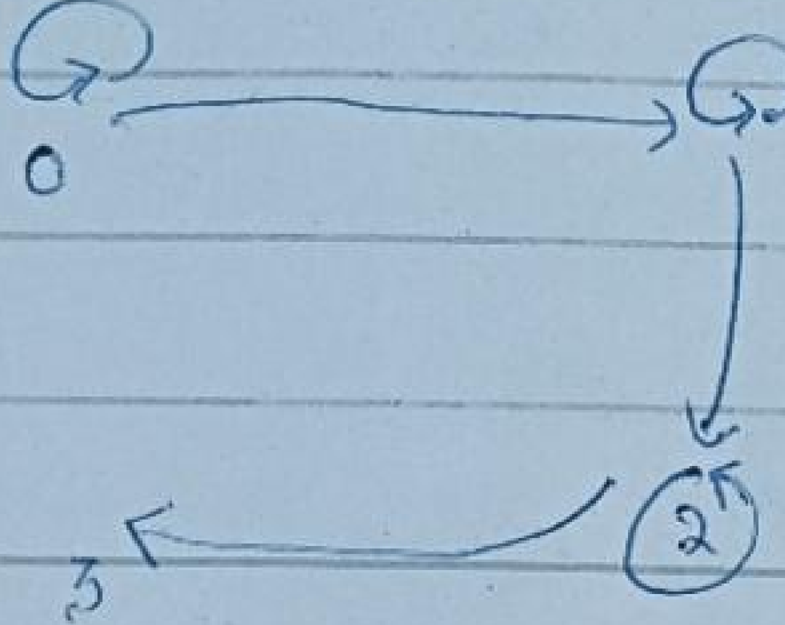
R_1 is not transitive.

$R_2 = \{(0,0)\ (0,1), (1,1), (1,2), (2,2), (2,3)\}$

$A = \{0, 1, 2, 3\}$

$R_2 = \{(0,0), (0,1), (1,1), (1,2), (2,2), (2,3)\}$

(a) Directed Graph



(b) No, R_2 is not reflexive because there is no loop at 3.

(c) No, R_2 is not Symmetric because between two number where there exists an allow, the allow goes only one directio

(d) No R_2 is not transitive though there is an allows between 0 and 1 and also allow between 1 and 2 but is no allow betwee 0 and 2

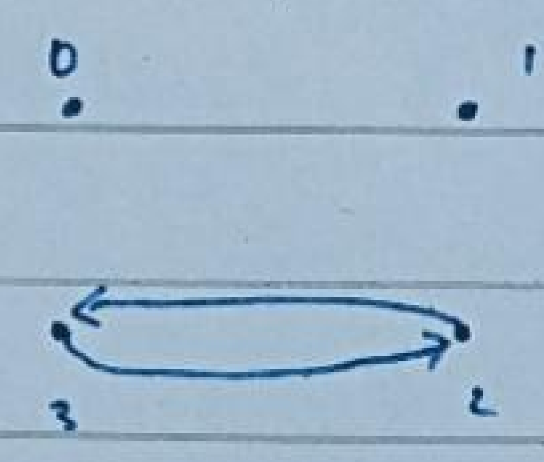
$R_3 = \{(2,3), (3,2)\}$

$A = \{0, 1, 2, 3\}$

(a) Directed Graphs

we note that contain

4 element and thus we will draw 4 Point. we label these Point 0, 1, 2, 3 which are the element of A.
For every element $(x, y) \in R$ with $x \neq y$ we draw an allow from x to y.
For every element $(x, x) \in R$, we draw a loop at the Point x.



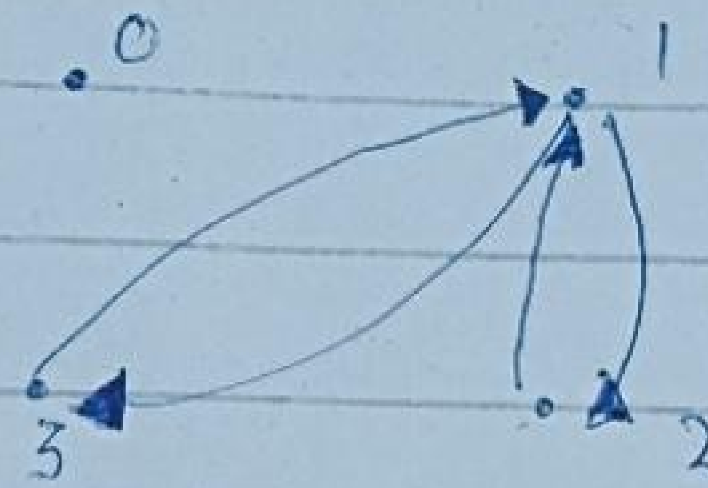
(b) The relation R_3 is reflexive if $(a, a) \in R_3$ for every element $a \in A$.
Since $A = \{0, 1, 2, 3\}$ R_3 is reflexise if it Contain $(0,0)$, $(1,1)$, $(2,2)$, $(3,3)$. we note that R_3 does not Contain $(0,0)$ and thus R_3 is not reflexisve. R_3 is not reflexive.
(C) The relation R_3 on a set A is Symmetric if $(b, a) \in R_3$ whenever $(a, b) \in R_3$ we note that $(2,3) \in R_3$ while $(3,2) \in R_3$ and there are no other Closeded Pairs in R_3, thus R_3 is symmetric.

R_3 is symmetric.

4 $R_4 = \{(1,2), (2,1), (1,3), (3,1)\}$

$A = \{0, 1, 2, 3\}$

(a) Directed Graph:



b) No, R4 is not reflexive because there is no loop at 1.

∴ R4 is not reflexsive.

c) Yes R4 is symmetric because between two number where there exist an allrow, the allow go both way

∴ R4 is symmetric.

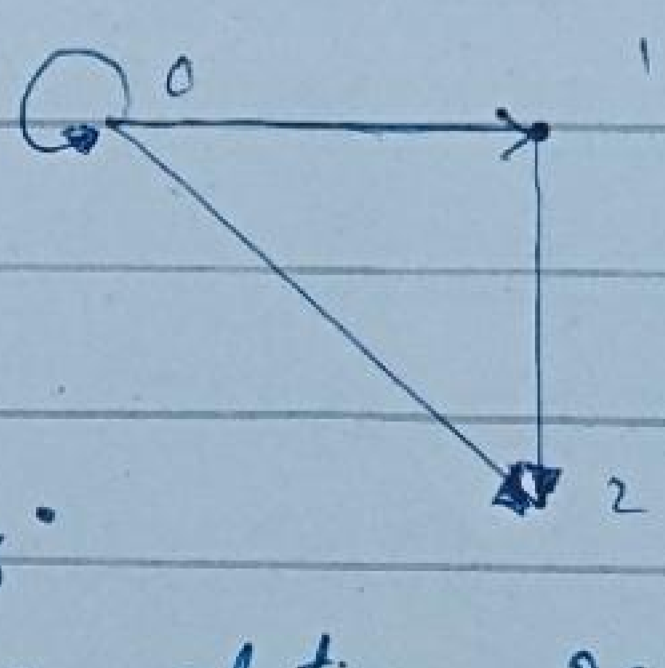
d) No R4 is not transitive though there are arrows between 2 and 1 and also arrows between 1 and 3 but there are no arrows between 2 and 3.

∴ R4 is not transitive.

5 $R_S = \{(0,0), (0,1), (0,2), (1,2)\}$
$A = \{0, 1, 2, 3\}$

a) Directed Graph:

we note A Contain 4 element and thus will draw 4 Points.
we label these Point 0, 1, 2, 3 which are the element of A.
For every element $(x,y) \in R$ with $x \neq y$ we draw an arrow from x to y.
For every element $(x,x) \in R$, we draw a loop at the Point x.



b) The relation R_S is reflexisive if $(a,a) \in R_S$ for every element $a \in A$.
Since $A = \{0, 1, 2, 3\}$ R_S is reflexisive if it contain $(0,0)$, $(1,1)$, $(2,2)$ $(3,3)$
we note R_S does not contain $(1,1)$
and thus R_S is not
refexisive

R_S is not reflexive.

(c) The R_5 on a set A is symmetric if $(b,a) \in R_5$ whenever $(a,b) \in R_5$
we note that $(0,1) \in R_5$ while $(1,0) \in R_5$ and thus R_5 is not symmetric
R_5 is not symmetric.

(d) The R_5 on a set A is transitive if $(a,b) \in R_5$ and $(b,c) \in R_5$ implies $(a,c) \in R_5$.

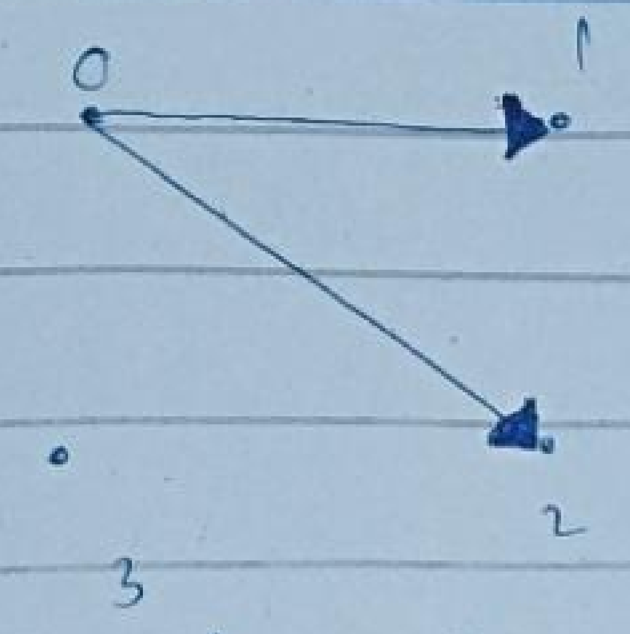
we note that $(0,1) \in R_5$ and $(1,2) \in R_5$ while $(0,2) \in R_5$ and thus R_5 is transitive as there are no other pairs for which transitivity can be ~~ee~~ checked. R_5 is transitive.

6 $R_6 = \{(0,1), (0,2)\}$

(a) Directed Graph:

$$A = \{0, 1, 2, 3\}$$

we note that A contain 4 element and thus we will draw 4 points. we label these point 0, 1, 2, 3 which are element of a. For every element $(x,y) \in R_6$ with $x \neq y$ we draw an arrow from x to y. For every element $(x,x) \in R_1$ we draw a loop at the point x.



b) The relation R_6 is reflensive if $(a,a) \in R_6$ for every element $a \in A$.
since $A = \{0,1,2,3\}$, R_6 is reflexsive if it contain $(0,0)$, $(1,1)$, $(2,2)$, $(3,3)$. we note that R_6 does not contain $(0,0)$ and thus R_6 is not reflensive.

R_6 is not reflexsive.

c) The relation R_6 on a set A is symmetric if $(b,a) \in R_6$ whenever $(a,b) \in R_6$ we note that $(0,1) \in R_6$ while $(1,0) \in R_6$ and thus R_6 is not symmetric.

d) The relation R_6 on a set A is transitive if $(a,b) \in R_6$ and $(b,c) \in R_6$ implies $(a,c) \in R_6$. we note that the if statement $(a,b) \in R_6$ and $(b,c) \in R_6$ is never true as there exists now such pairs in R_6. when the if-statement is false and thus R_6 is transitive.

R_6 is transitive.

7 $R_7 = \{(0,3), (2,3)\}$

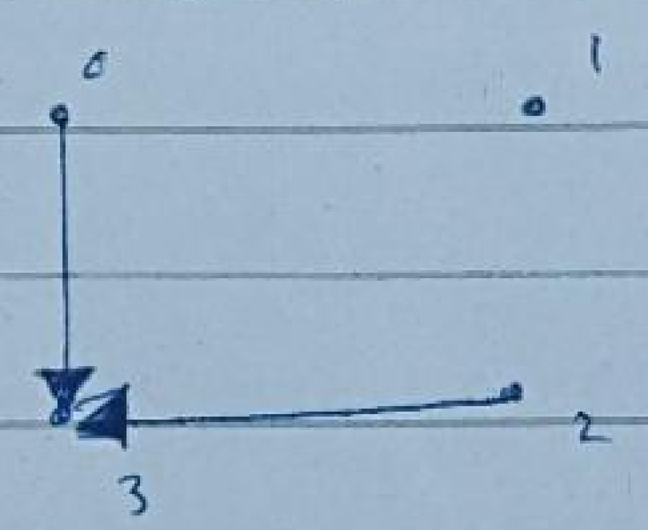
$A = \{0, 1, 2, 3\}$

(a) Directed Graph:

we note that A contain 4 element and thus we will draw 4 Points. we label these Point 0, 1, 2, 3 which are the element of A.

for every element $(x,y) \in R$ $x \neq y$ we draw arrow x to y.

For every element $(x,x) \in R$, we draw a loop at the Point x.



b) The relation R_7 is reflexsive if $(a,a) \in R_7$ for every element $a \in A$.

since $A = \{0, 1, 2, 3\}$ R_7 is reflensive if it contain $(0,0), (1,1), (2,2), (3,3)$

we note that R_7 does not contain $(0,0)$ and thus R_7 is not reflensive.

R_7 is not reflexsive.

c) The R_7 on set A symmetric if $(b,a) \in R_7$ whenever $(a,b) \in R_7$ we note that $(0,3) R_7$ while $(3,0) \in R_7$ and thus R_7 is not symmetric

(d) The R_7 on a set A is transitive if $(a,b) \in R_7$ and $(b,c) \in R_7$ implies $(a,c) \in R_7$.

The note that if statement $(a,b) \in R_7$ and $(b,c) \in R_7$ is never true as there exist no such pairs in R_7. How evers on if - then statement is always true.

R_7 is transitive.

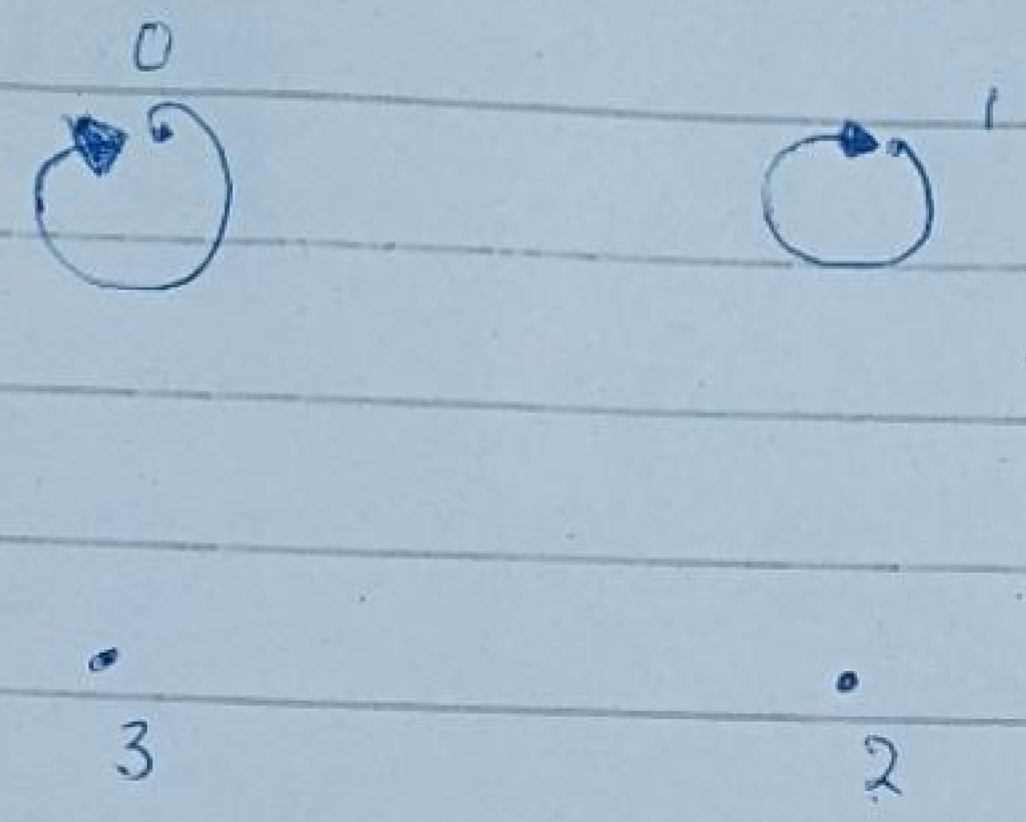
$8 = R_8 : \{(0,0), (1,1)\}$

$A = \{0,1,2,3\}$

(a) Directed Graphs

we note that certain 4 element and thus we will draw 4 Point. we labels these Point 0, 1, 2, 3 which are the element of A. For every element $(x,y) \in R$ with $x \neq y$. we draw on arrow from $x + y$.

For every loop element $(x, x) \in R$,
we draw a loop at one point.



b) The relation R_8 is reflexive $(a, a) \in R_8$ for every element a $\in A$.
Since $A = \{0, 1, 2, 3\}$ R_8 is reflexive if it contain $(0,0)$ $(1,1)$ $(2,2)$ $(3,3)$
we note that R_8 does not contain $(2,2)$ and thus R_8 is not reflexive.

R_8 is not reflexive.

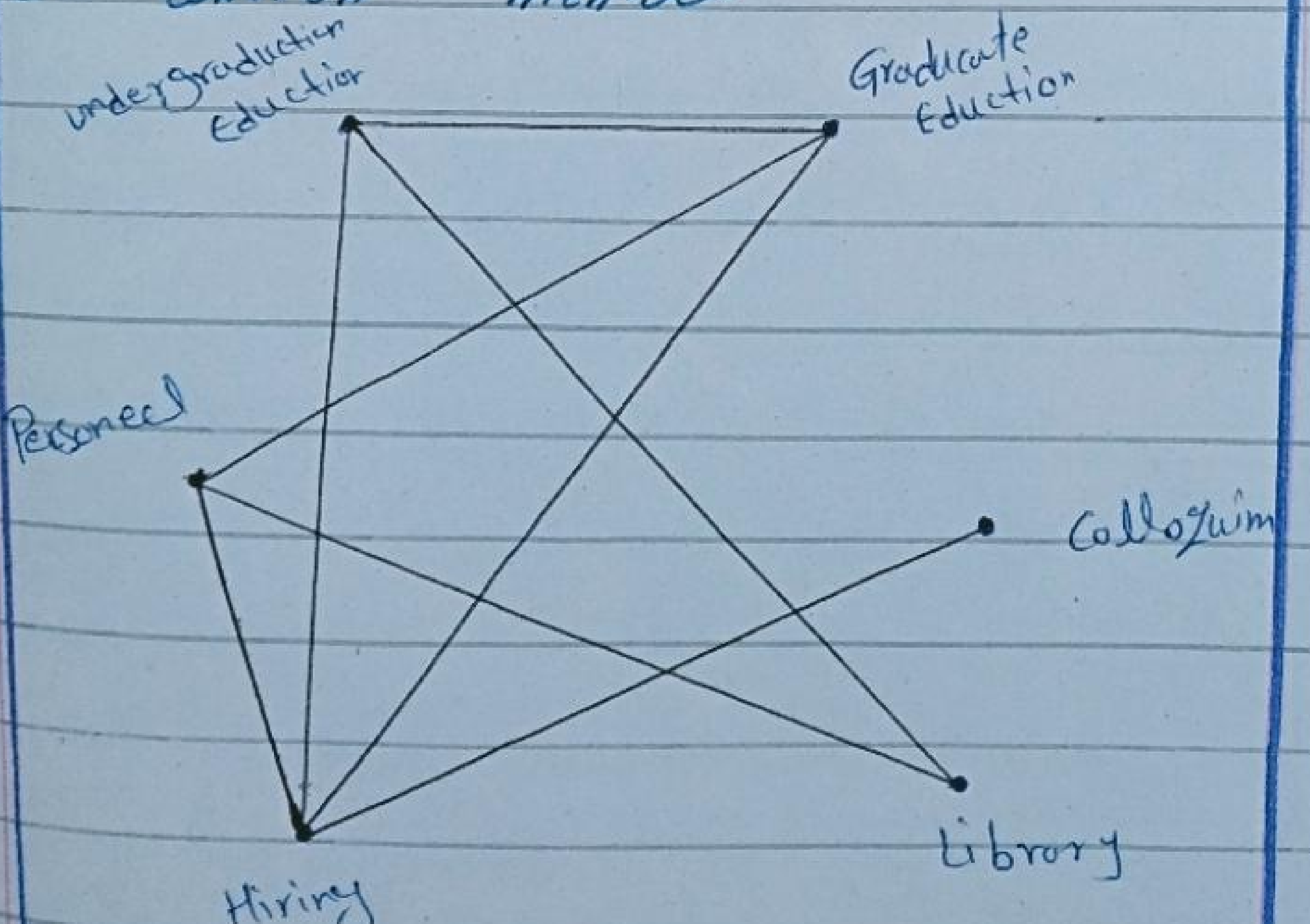
c) The relation R_8 on a set A is symmetric if $(b, c) \in R_8$ whenever $(a, b) \in R_8$. we note that $(0,0) \in R_8$ while $(0,0) \in R_8$ and $(1,1) \in R_8$ while $(1,1) \in R_8$. There are no other element in R_8
so the R_8 is symmetric.

R_8 is symmetric.

(d) The R_8 on a set A is transitive if $(a,b) \in R_8$ and $(b,c) \in R_8$ implies $(a,c) \in R_8$.
we note that the statement if $(a,b) \in R_8$ and $(b,c) \in R_8$ is never true for two distinct pairs as there on other such pair in R_8. when if statement is false so R_8 is transitive
R_8 is transitive.

Question = 10 Answer

We have been given 6 Committees ungergraducate Education, Graduction eduction Colloquim, Library, Hiring and Personal. Let us then represent the scheduling Problem by a graph with 6 vertices and each vertices represent one of the Committees. Next, we draw an edge beteew two vetices, if the two Committees have a common member.



Next we will assign a color to each other vertex such that no two adjacent vertices have the

Same colour thus no two vertices that are connect by an edge will have the same colour.
we note that vertics 'Hiring' has the most edge connecting the vertics to another vertex. Thus let us colour Red.

Hiring = Red

2 Next the vertix 'Library' is the only vertex that is not connect to the vertex "Hirary" by an edge and thus we can color 'Library' the same as 'Hiring' Let us color the vertex "Library" with the color Library = Red'
Next we note the vertex "Personnel" is connect to vertex "Hiring" and vertex 'library' by an edge. Thus we cannot colour the vertex Personnel with Red, let us then color this vertex with People.

Personnel = Purple

3 Next we note vertex "Graduate Education is connect to vertis Hiring and vertex Personnel

by on edge. Thus we cannot colour the vertex Personeel with Red nor with Purple, let us then color this vertex with blue.

Graduate Education = blue.

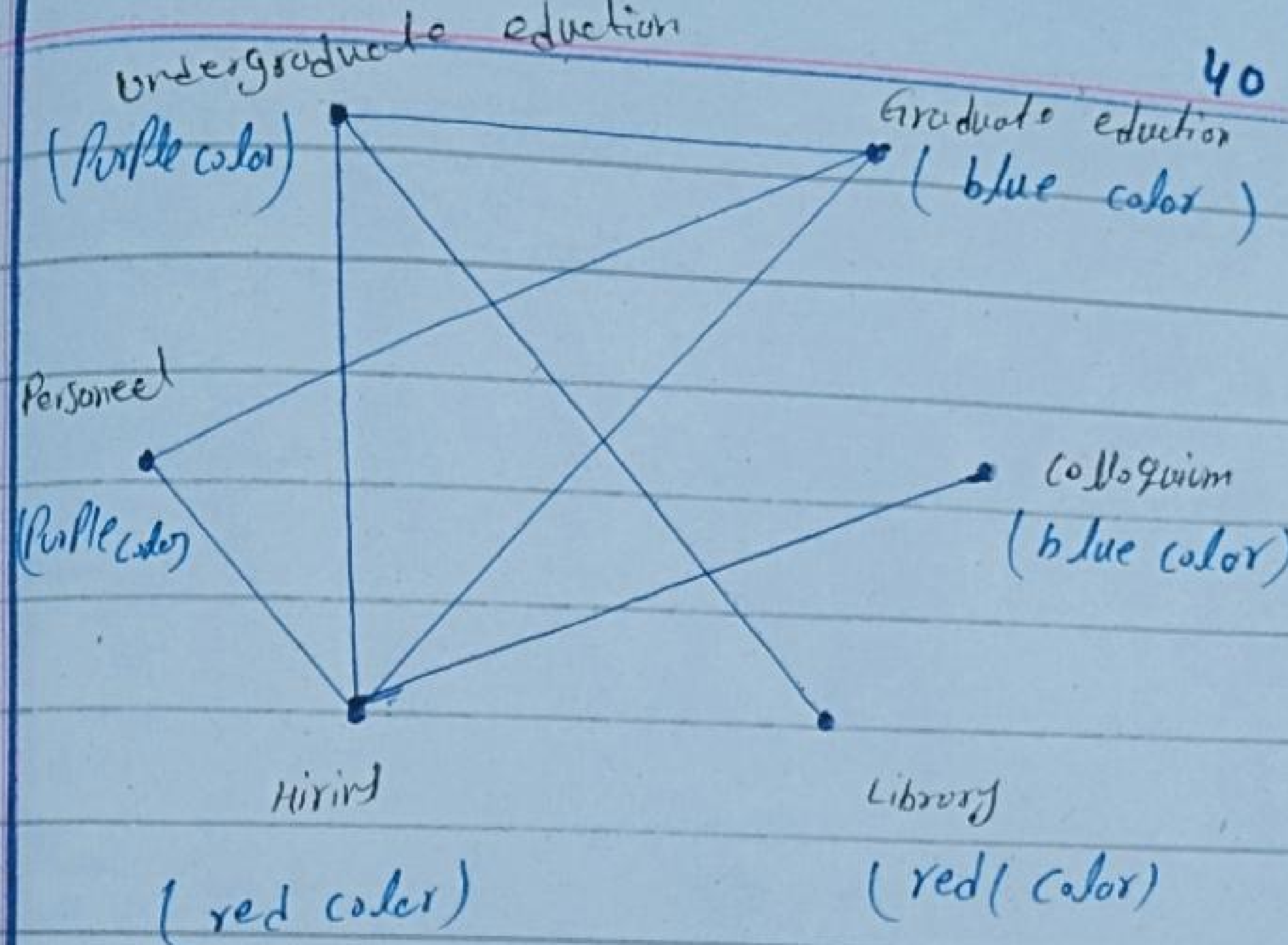
4 Next we not that vertex undergraduate education is connect to vertex by on edge. Thus we cannot colour the vertex Persneel with Red nor with blue let us then color
5 this vertex with Purple.

undergraduate education = Purple

And then connect the collogium with the color blue.

Colloquium = blue

8 we then note that we colored all vertex such that no adjecent vertices have the colour and we used exactly 3 color.



we can then schedule the meeting by assigning each time slot to a colour. Thus let us assign the first time slot to the red, colour the second slot time slot to the blue color and third time slot to the Purple colour

First time slot => Hiring and Library

Second time slot => colloquim and Graducation

Third time slot => undergraduate education and Personeel.

END