$S_1 R_{S_2}$ iff $S_1 \cap S_2 = \phi$

Que :-

1. How many components = 1 (Connected)
2. max degree Δ = 3
3. min degree δ = 3
4. How many isolated vertex = 0

every subset of 2 element so

$\{1, 2, 3, 4, 5\}$

eg, for a node, a subset let $\{1, 2\}$

$\{\{1,2\}\ \underline{345}\}$ $\rightarrow$ $\underline{{}^3C_2 = 3}$

eg:- Consider a set $A = \{1, 2, 3 \ldots n\}$

take all subsets

so # of vertices $= 2^n$

given, $S_1 R_{S_2}$ iff $|S_1 \cap S_2| = 2$

i. How many Isolated vertex = $\underline{n+1}$

ii. Components = $\underline{n+2}$

$S_1 R_{S_2}$:- $\{1,2\}, \{2,3\} \ldots$ $\{1\ 2, \ldots n\}$

$S_1 R S_2$:- $\underbrace{\{\phi\} \ldots \{1\}, \ldots \{n\}}_{(n+1)}$

components :- $(n+1)$ isolated, 1 connected

so $\underline{n+2}$

iii) max degree :-

Connectivity of graph :-

i) Connected and disconnected graph

ii) CV, CE, Cset

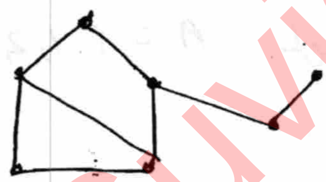
iii) VC & EC → VDG

vertex cut, edge cut

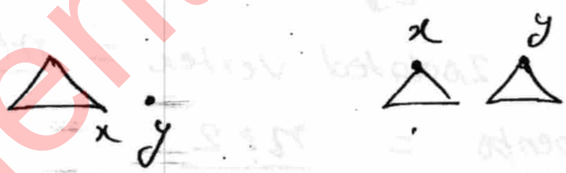
iv) SC, VC, WC,

i) Connected & disconnected

G is connected iff $\forall\, x, y \in G$ $\exists$ path $x \leftrightarrow y$



G is disconnected iff $\exists\, x, y \in G$ which has no path



⇒ k = no. of components i.e. No. of connected pieces

k = 3 ; k = 4

:- Relation in n, e, k & simple graph

V.Imp. ★★★

$$\boxed{n-k \le e \le \frac{(n-k+1)(n-k)}{2}}$$

If $n = 10$
$k = 3$ or $k \geq n - e$

$e \geq n - k$
$e \geq 10 - 3$
$\underline{e \geq 7}$

eg:- graph of order 10 & ~~size 15~~ components = 3

$\cancel{k \geq n - e}$ $e = ?$

$\cancel{k \geq 10 - 15}$ $10 - 3 \leq e \leq \frac{(10-3+1)(10-3)}{2}$

$7 \leq e \leq 28$

:- order 10, size = 4

$k \geq n - e$
$k \geq 10 - 4$
$\underline{k \geq 6}$

:- order 10, size = 15

$k \geq n - e$
$k \geq -5 \rightarrow$ If -ve take it as $\underline{1}$

so $k \geq 1$

:- order 10, size = 15 $n = 10$
k is atmost ? $e = 15$

$$e \leq \frac{(n-k+1)(n-k)}{2}$$

$$e \leq \frac{(10-k+1)(10-k)}{2}$$ gonna be long

so put the options.

a) 3 b) 4 c) 5 d) 6 Put one by one

:- maximum number of edges in a disconnected graph :- with n vertices

for minimum disconnected graph $k = 2$

$$e \le \frac{(n-k+1)(n-k)}{2}$$

$$e \le \frac{(n-2+1)(n-2)}{2}$$

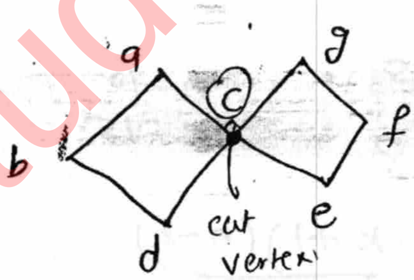
$$\boxed{e \le \frac{(n-1)(n-2)}{2}}$$

:- cut vertex, cut edge & cut set :-

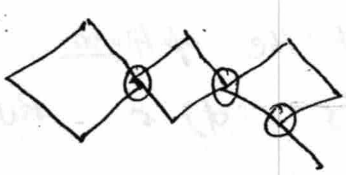
A vertex "v" is a cut vertex iff removal of v, disconnect the graph

(or)

⇒ A cut vertex is a such a vertex whose removal increases the (k) no of components in a graph.

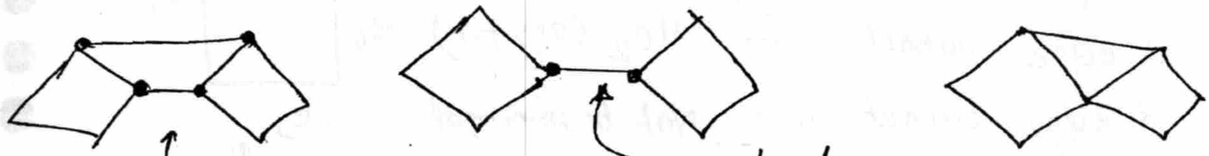


cut vertex also called "Articulation point" or 'cut node'

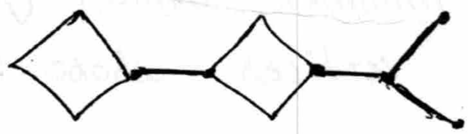


3 Articulation Points

Cut-edge :- (Bridge) cut edge is an edge, whose removal increases the no. of components.



'Pendant edge' is always an cut edge.

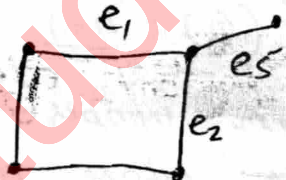


4 cut edges

Cut set :-

Note :- Every spanning tree of a graph must include every 'cut edge'.

"Cut set" is a minimal set of edges whose removal will disconnect the graph. (or) increase No. of components ($k\uparrow$)



:- which is not a cut set

a) $\{e_5, e_3\}$ ✗ because its subset is a cutset $\{e_5\}$

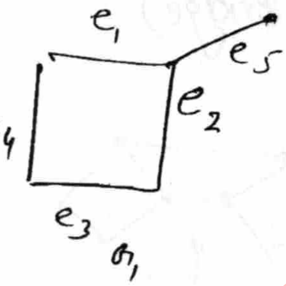
b) $\{e_5\}$

c) $\{e_1, e_2\}$

d) $\{e_3, e_4\}$

Note :- Set is cutset, If its subset is not a cutset and its removal increases $k\uparrow$

eg :- How many cutsets ?



1 edge cutset → $\{e_5\} = 1$

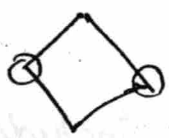
2 edge cutset → $^4C_2$ (any two)

3 edge cutset — Not be minimal

⋮

so # cutsets in G_1 = $^4C_2 + 1$

- Vertex connectivity : k_G : minimum number of vertices whose removal disconnect the graph.



$\Rightarrow k_G = 2$

If there is a cut vertex in graph then $k_G = 1$
otherwise $k_G \geq 2$

$$\boxed{k_G \leq \lambda_G \leq \delta}$$

for complete graph $\lambda(k_G) = \overline{n-1}$

By definition :- complete graph $k(G) = \overline{n-1}$

:- Edge connectivity : λ_G : minimum number of edges ~~vertices~~ whose removal disconnect the graph.

In cycle graph $(k_G) = 2$

~~In tree edge connectivity (λ_G) = 1~~

Every tree has $n-1$ cut edges.

n vertex & l leaf

Cut vertex = Internal vertex = n-l

cut edge = n-1

$$\boxed{K_G \le \lambda_G \le \delta \le \left\lfloor \frac{2e}{n} \right\rfloor \le \Delta}$$

eg:- $n=10, \ e=15$

max K_G & max λ_G = ?

$VC \le \left\lfloor \frac{2e}{n} \right\rfloor = \left\lfloor \frac{30}{20} \right\rfloor = 1.$

$VC \le 3$

$EC \le \left\lfloor \frac{2e}{n} \right\rfloor$

$EC \le 3$

If e, n, & δ are given then, use δ ie

$K_G \le \lambda_G \le \delta$

$\Rightarrow$ If graph ~~with~~ with n vertices and is 3-connected $\rightarrow$ It means removal of 3 vertex (some) in graph will disconnect the graph.

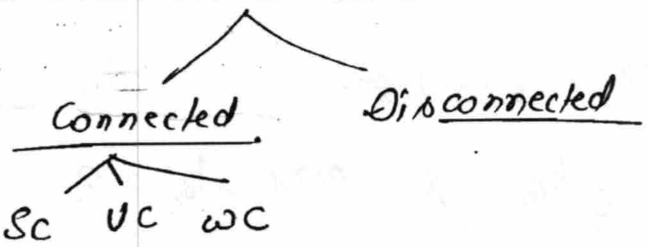
If graph 3-line connected $\Rightarrow$ there are some 3 edges whose removal disconnect the graph.
edge

& removal of $\le$ N (3) will not disconnect the graph.

1-connected graph :- Its a graph which has a cut vertex.

so Its also called '**seperable graph**'

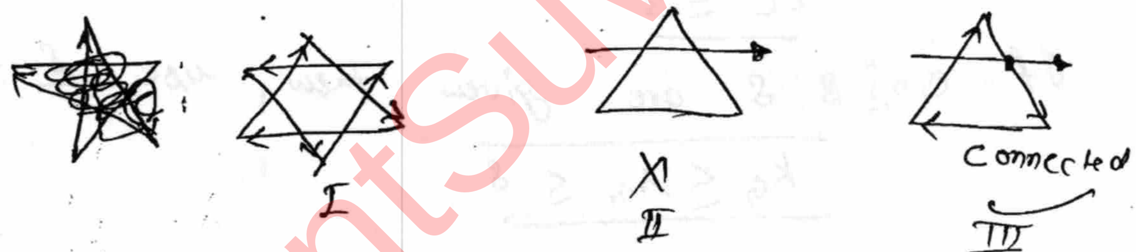
Digraph :-

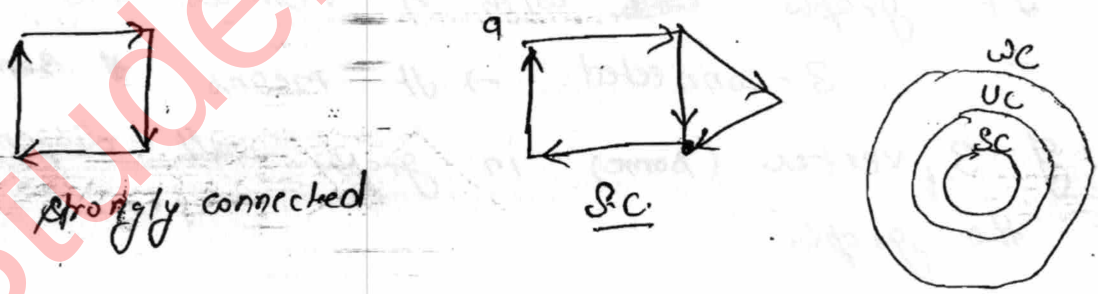


Sc : strongly connected : $\forall x, y \in G$ $x \to y$ & $y \to x$

Uc : unilaterly connected one direction path either $x \to y$ or $y \to x$

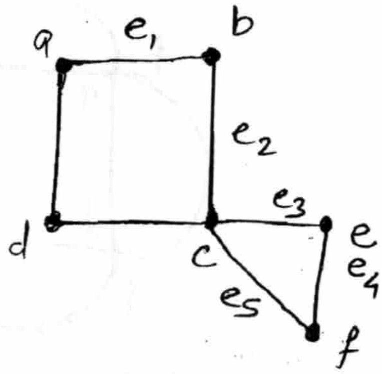
wc : weakly connected $\to$ just connected





Euler graph :-

:- walk :-



edges can't be repeated
vertex can be repeated.

abcef ✓

abcba ✗

acef ✗

:- Path :- < closed path (starting & ending vertex are same)
open path (No vertex are repeated)

:- In path both vertex and edge can't be repeated.

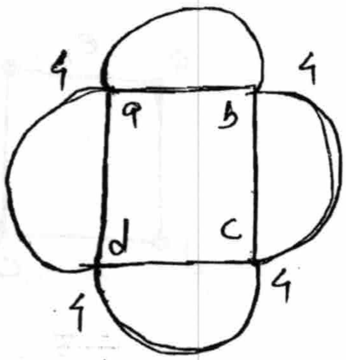
:- Length of the cycle = no. of edges or no. of distinct vertices.

:- Every u-v walk contains a u-v path.

:- "A Graph G is Euler Iff G contain an euler cycle."

Euler graph - Iff G is connected & every vertex has "even degree"

Euler cycle :- Closed walk which include every edge exactly once

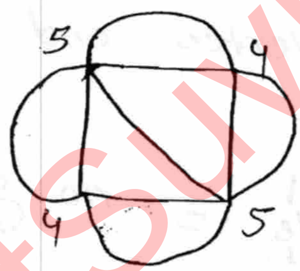


euler graph

:- A disconnected graph can't be euler graph.

Euler path :- open walk which include every edge. exactly once.

:- euler path is exist ~~when~~ Iff graph is Connected and exactly 2 vertices has odd degree

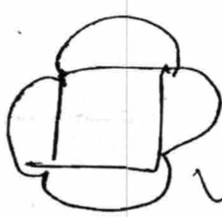


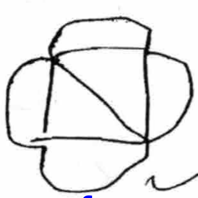
Euler path exist but not euler cycle so not euler graph

:- If graph contain Euler path, then It will never contain euler cycle and viceversa.

:- Unicursal graph :- Iff graph contains euler path i.e. exact two vertex of odd degree.

:- Traversable or Tracable :- Iff the graph either contain euler cycle or euler path. i-e [illegible]

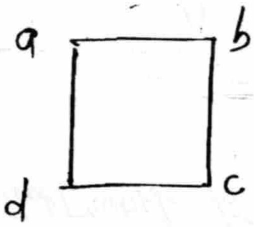




Hamiltonian graph :-

A graph G is hamiltonian iff it contains Hamiltonian cycle.

<u>Hamiltonian cycle</u> :- <u>closed path</u> & include every vertex.

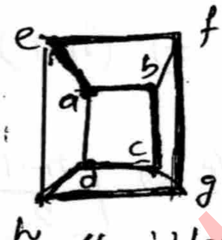


Hamiltonian graph

abcda

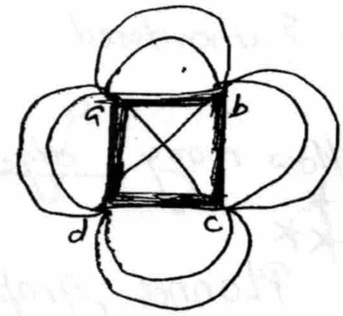
closed path with all vertex

<u>Hamiltonian path</u> :- open path which include every vertex



Hamiltonian graph

abcdhgfe



Hamiltonian graph

1. Every Hamiltonian graph ⇒ has no pendant edge.
2. Pendant edge ⇒ Not Hamiltonian

2. <u>Dirac's theorem</u> : In a connected graph → $\forall v \in G$ $\deg(v) \geq n/2$ ⇒ G is Hamiltonian

:- If degree sequence given of connected graph

(3, 3, 3, 4, 4, 5)

$n = 6/2 = 3$ so Hamiltonian

as 3 is ≥ to all degrees

:- ORE's theorm :-

$\forall$ u, v $\in$ G $\quad \boxed{deg(u) + deg(v) \geq n}$

Non adjacent

:- Every Hamiltonian cycle itself contain a Hamiltonian path.

:- In complete graph k_n # of Hamiltonian cycles $= n!$

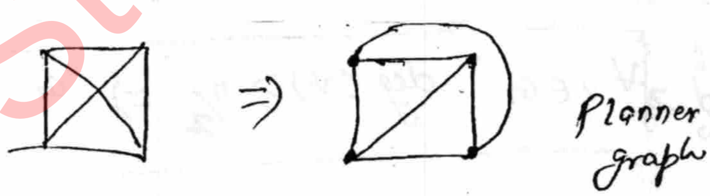
:- Hamiltonian cycle with starting & ending with same vertex $a - - a \Rightarrow (n-1)!$

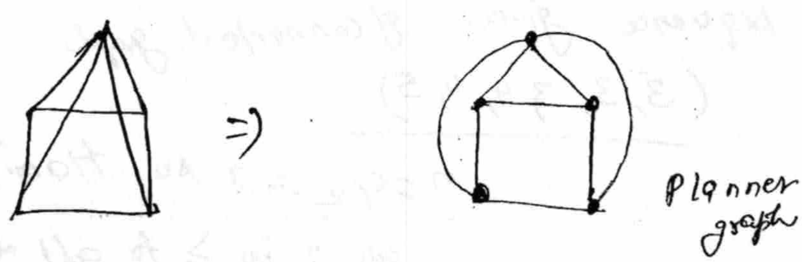
:- ? unordered Hamiltonian cycle $\Rightarrow (n-1)!$

:- How many "edge disjoint Ham cycle $\Rightarrow \left\lfloor \frac{n-1}{2} \right\rfloor$

Planner graph :-

$\Rightarrow$ G is planner iff it it has planner embedding with no edges crossing each other.





1. Theorms :-

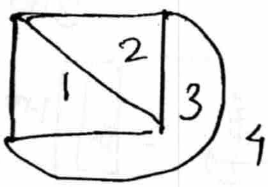
1. Euler's formula for planner graph :-

Planner graph $\boxed{r = e - n + (k+1)}$

$k = 1$

Connected planner graph $\boxed{r = e - n + 2}$

r = regions (or faces) in the planner embedding.



$\Rightarrow$ 4 regions or faces

3 closed faces, 1 $\rightarrow$ open face

Que:- 3-regular connected planner order 10

How many face in planner graph embedding?

$n = 10$
$e = 15$
$k = 1$

$r = e - n + (k+1)$
$r = 15 - 10 + (2)$
$r = 7$

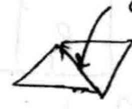
eg:- order 10 planner graph $k = 3$ # closed ~~pl~~ faces?

$e = 15, \ n = 10, \ k = 3$

$r = 15 - 10 + (3+1)$

$r = 5 + 4 = 9 \Rightarrow 9 - 1 = 8$ closed faces (open face)

Que: Order 10, connected planner graph, every face is bounded by exactly 3 edges.



counted twice

so edges $= 3r$

$e = 3r/2 \Leftarrow$ for every region edges counted twice

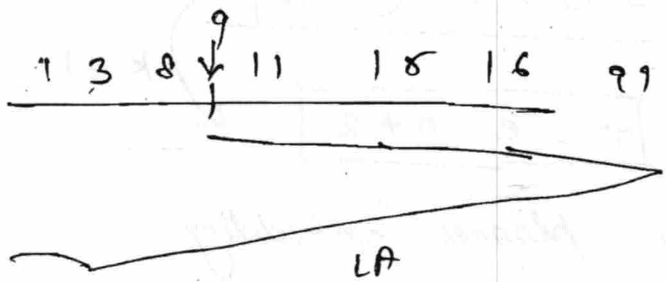
$r = e - n + 2$

$r = 3r/2 - 10 + 2 \Rightarrow 2r = 3r - 20 + 4$

$r = 16$ so $e = \frac{3r}{2} = 24$

27 c

Scan



22 a

23

← 32 bit →

19	13

$\cancel{8192}$

8192

4

2048 × 4

$2^{11} \times 2^{2}$

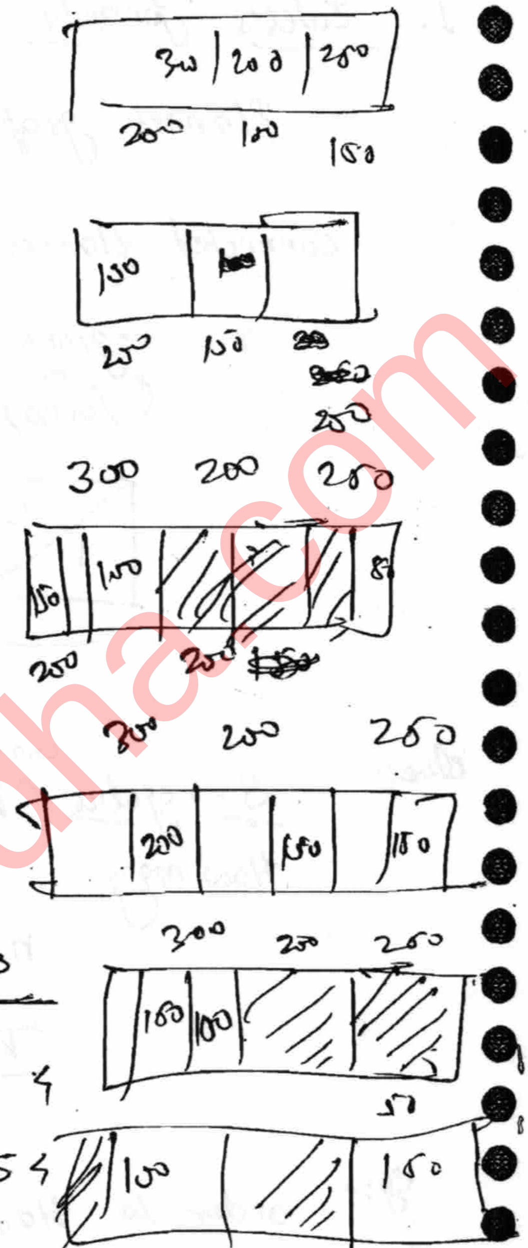
2^{13}

PA

← 22 →

9	13

23 9



24

01

~~ABCD~~ E

Need

P_0	0	1	0	0	2
P_1	0	2	1	0	0
P_2	1	0	3	0	0
P_3	0	0	1	1	1

00 x 2 3

x = 1

1 1 3 4 4

3 2 6 5 4

24 C

25 b $U = \cancel{3}2$ $V = \cancel{0}2$

26

d Head P_2, P_1, P_2, P_3, P_2 Tail C P_4, P_2, P_5

$S = \cancel{1}\,0$ $T = \cancel{1}\,0$

P_1	P_2	P_1	P_2	P_3	P_2	P_2	P_4	P_2

0 1 2 3 4 5 6 7 8 9

1 5 X 4 X 3 2

P_1

29 1024 Byte bl

Block no. 1024

$\frac{1024}{64}$

$\frac{2^{12}}{2^{8}} = 2^{4} = (16)^{3}$

$2^{12} = (2^{4})^{3} =$

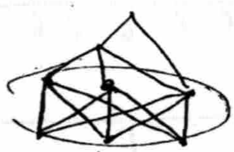
28 a

$(P \uparrow q) \uparrow (P \uparrow q)$ $\qquad \overline{\overline{(P \cdot q)} \cdot \overline{(P \cdot q)}}$

$(P \downarrow q) \downarrow_1$ $\qquad (P \cdot q) + (Pq)$ $\quad \underline{Pq}$

2) Kuratowski's theorm :-

:- G is planner iff it does not contain K_5 or $K_{3,3}$ as a subgraph & graphs which are homeor-morphic to K_5 or $K_{3,3}$.



$K(3,3)$

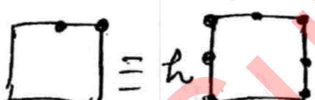
so not planner

↑ Homeomorphic to K_5

Homeomorphism :-

:- every isomorphic is homeomorphic

:- ~~ab~~



:- Keep on fusing all 2-degree vertices to check whether the graph is K_5 or $K_{3,3}$ (Homeomorphic check).

:- 3) Connected Planner Simple graph (CPS)

CPS $\Rightarrow e \leq 3n-6$

4.) CPS + No triangles (Δ's) $\Rightarrow e \leq 2n-4$

5.) CPS $\Rightarrow \delta \leq 5$

6.) CPS + No Δ's $\Rightarrow \delta \leq 3$

eg:- max no. of edges in CPS with order 10

$e \leq 3 \times 10 - 6 \Rightarrow \underline{e \leq 24}$

"girth" :- Length of the shortest cycle in graph

3pec s 10P / m

(1) d (2) b

(1) c $\frac{1}{3}$ $10P/60$ $\frac{1}{6}$

1P – 6

1P – 3

optimal

(5) 1 2 3 4 2 1 5 6 2 1 2 3 7 6 3 2 1 2 3 6

(c)

1 1 1 1 1 1 1 1 1 1 1 1 7 7 7 7 1 1 1 1

2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2

3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3

4 4 5 6 6 6 6 6 6 6 6 6 6 6 6 6 6

F F F F F F F F

(6) d (7) b (8)

(8) c (10) b

(11) e

(12) b

← 32 bits →

17	15

P_1, P_2, P_3, P_4 ⇒ 20

4 3 7

3 2 6 (9)

PA

← 30 bit →

15	15

$\frac{1024 B}{4B}$

$\frac{2^{10}}{2^2} = 2^8$

$\frac{4000 B}{}$ = 256

(14) 1KB

0 – 999 – 1

1000 – 1999 – 2

2000 – 2999 – 3

3000 – . 4

(13) a $\frac{2^{17} * 2B}{2^{18}}$ = 256KB

(14) b

(15) a

(16) d $S=0$, $T=0$

$s_0 = 1$, $s_1 = 0$, $s_2 = 0$

Print 0 0 0

(18)

(17) (9)

4		32

S

S d

4	32

VAS

24	8

d

(18) P.T.E.S. = 4B

P.L.A.S. = 2^{38} = 38

← 38 →

(C) Let x be

$$\frac{2^{38}}{x} \times 2^2 = \frac{2^{40}}{x}$$

$$\Rightarrow \frac{2^{42}}{x^2} \Rightarrow x^3 = 2^{42}$$

(C) $x = 2^{14}$

(19) 16 *

1024 * 4096

$2^4 \times 2^{10} \times 2^{12}$

256

~~2048~~

~~8~~

---

(20)

S = 8 ms

S_m = 20 ms

P_m = 70% = 0.7

200 ns > P ((0.7 * 20 ns) + (0.8)(0.3))) + (1-P) * 100 × 10 ns

~~14 ns~~

14 ns + 2.4

200 ns > 16.4 P ns + 100 ns − 100 P ns

10^{-3}

150 ns ≥ (16.4 × 10^{-6} × 10^{-9} − 100 P ns)

$\frac{100}{16.4}$ 16.4 10^{-7} . 10^{-7}

(16.4 × 10^{4})

① c

$\bar{A}C$

$B(A+\bar{C})+\bar{A}C)$

$AB + AB\bar{C} + ABC + \bar{A}C$

$AB + AB + \bar{A}C$

$AB + \bar{A}C$

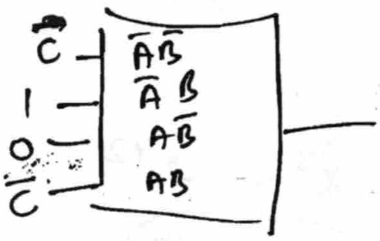
$A \odot B$

$A \odot 1$

$A \odot C$

$1 \odot 0 = 1$

$1 \odot 1 = 0$



$\bar{A}\bar{B}\bar{C} + \bar{A}B + AB\bar{C}$

010 (2)

011 (3)

001

110 (6)

1, 2, 3, 6

② a

③

$16 = \frac{5 \cdot 20 \times 10^{-6}}{Pd}$

$\Delta t = 5 \times 10^{-6}$

$\Delta t = \frac{1}{f_c}$

$\frac{1}{N f_c}$

20×10^{-6}

$= \frac{1}{16 \cdot 5 \times 10^{6}}$

④ c

$J_1 K_1$

1 1

$J_2 K_2$

$\bar{Q}_1$

$Pd =$

$Q_2 \; Q_1 \; Q_0$

1 $\bar{Q}$ $\bar{Q}_1$ J

⑤ c

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

⑥ d

⑦ c

$2 \times 4 \times 5 = 40$

$\overline{\bar{A}B + \bar{A} + AB}$

$\overline{\bar{A}B} \cdot \bar{\bar{A}} \cdot \overline{AB}$

$A\bar{B} \cdot A \cdot (\overline{AB})$

$\overline{AB} \quad B$

$\Delta t = P n \delta$

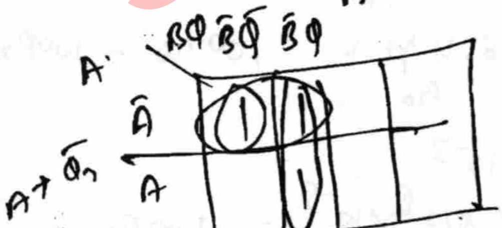
$f_c = 5\,MHz$

$\bar{A} Q_n$

$A + Q_n \; 1$

⑨

J	K	Q_n	Q_{n+1}	J	K
A	B				
0	0	0	1	1	X
0	0	1	1		
0	1	0	0		
0	1	1	0		
1	0	0	0		
1	0	1	1		
1	1	0	0		
1	1	1	0		



$\bar{A} + \bar{Q}_n \quad \bar{A}\bar{B} + \bar{B}Q_n$

$\bar{A}Q_n \quad \bar{B}(\bar{A} + Q_n)$

$\bar{A} + Q_n$

A

(11) b

(17) d

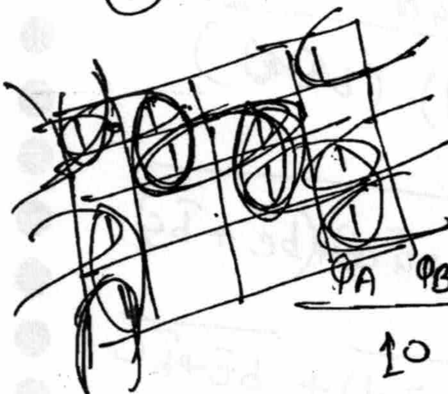
(22) b

(23) c

(28) c

(29) b

Q_A	Q_B	Q_C	J_A	K_A	J_B	K_B	J_C	K_C
0	0	0	1	1	$\bar{Q}_C$	1	Q_B	1
0	0	0	1	1	1	1	0	1
1	1	0	1	1	1	1	1	1
0	0	1	1	1	0	1	0	1
1	0	0	1	1	1	1	0	1
0	1	0	1	1	1	1	1	1
1	0	1	1	1	0	1	0	1
0	0	0						



Q_B 0 Q_A Q_A 0 Q_B 0 Q_C

Q_A	Q_B	J_A	K_A	J_B	K_B
1	0	1	0	1	1
1	1	0	0	1	1
1	0	0			

$\frac{5}{2}$ 6 $\frac{13}{2}$

(2,3,4) $n = 8$

(2,5,7)

25 ns

5 ns

$\frac{1}{205}$ 200 + 5

$\frac{1}{256}$

6(6+7)

$\frac{6 \times 7}{2}$ N

(21)

(2,3,4)

(1,3,6,7)

$f = 0$

(0,1) = 1

(1,1) = 1

(1,0) = 0

AB	Q_n
00	1
01	1
10	0
11	1

(2,3,4)

(2,4,5)

(5)

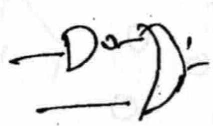
(0,1,3,5,7)

(2,4,5,8)

(2,4)

$\bar{A} + B$

$A\bar{B} + \bar{A}B + AB$



$A\bar{B}$

$\bar{A}\bar{B}$

flauci nancini halbilifalcin — "Keneth Rosen"

longest word in dictionary

1.—

$1+\omega+\omega^2=0$

$\omega+\omega^2=-1$ (5), (9)

ω^3 1

(4) $\frac{5!}{3!} \times 4!$

(8)

$4-1+6C6$

4^5-

$({}^nC_1+{}^nC_2+{}^nC_3+\ldots)$

$\overline{a\bar{d}+\bar{a}d}$

$\overline{(A\oplus d)\cdot(b\oplus c)}$

$\overline{(a\bar{d}+\bar{a}d)\cdot(b\bar{c}+\bar{b}c)}$

$\overline{(a\bar{d}+\bar{a}d)}+\overline{b\bar{c}+\bar{b}c}$

$(\bar{a}+d)\cdot(a+\bar{d})$

9C6

$4-1+4C4$

9C4

$5\times 4\times 3 \times 4!$

atleast 1

≥ 1

$=0$

$20\times 24 = 480$

$A\bar{B}\bar{C}D + A\bar{B}CD$

$A\cdot[\bar{B}\bar{C}D+BCD]$

$AB\bar{C}D+ABCD$

4^5 4^5-

5: A B C D — 1, 4; 4, 1; 0, 0; 0, 0

5: 1 1 2 — $\frac{5!}{3!\,2!}\times 4!$