2019-20 (4

18CS36

USN

RV COLLEGE OF ENGINEERING

(An Autonomous Institution affiliated to VTU)

III Semester B. E. Additional Examinations Dec-2020

Computer Science and Engineering

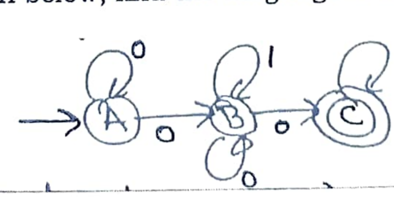
DISCRETE MATHEMATICAL STRUCTURES

Time: 03 Hours *Maximum Marks: 100*

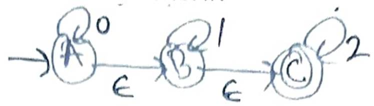
Instructions to candidates:

1. Answer all questions from Part A. Part A questions should be answered in first three pages of the answer book only.
2. Answer FIVE full questions from Part B. In Part B question number 2, 7 and 8 are compulsory. Answer any one full question from 3 and 4 & one full question from 5 and 6

PART-A

1	1.1	How many bit strings of length 8 either start with a 1 bit or end with the two bits 00?	01
	1.2	How many different strings can be made from the letters in $ABRACADABRA$ with all As must be consecutive.	01
	1.3	Give the recursive definition of the sequence $a_n, n = 1,2,3, \ldots\ldots$ if $a_n = n(n+1)$.	01
	1.4	Find $f(5)$ if f is defined recursively by $f(0) = f(1) = 1$ and for $n = 1,2, \ldots\ldots\ldots f(n+1) = f(n)f(n-1)$.	01
	1.5	Let $p(x,y)$ denote the sentence "x divides y". What is the truth value of $\forall x \ni y\, P(x,y)$ where the domain of x, y is the set $\{1,2,4,6,12\}$?	01
	1.6	Express the negation of the statement so that all negation symbols immediately precede predicates. $\forall x \ni y(P(x,y) \wedge \ni zR(x,y,z))$.	01
	1.7	Let $A = \{1,2,3,4\}$. The relation $R\ on\ A$ is given by the matrix M_R. Determine the properties of R. $M_R = \begin{bmatrix} 0 & 1 & 0 & 1 \\ 1 & 0 & 1 & 1 \\ 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix}$.	02
	1.8	If $\{\{a,c,e\},\{b,d,f\}\}$ is a partition of the $set\ A = \{a,b,c,d,e,f\}$. Determine the corresponding equivalence relation induced by this partition.	01
	1.9	Find $GLB(\{15,45\})$ and $LUB(\{3,5\})$ in the $POSET(\{3,5,9,15,24,45\}, 1)$.	02
	1.10	Determine the nature of the function $f: R \rightarrow R$, also determine the range of $f(R). f = x^2 + x$.	01
	1.11	For the NFA given below, find the language of the given NFA. 	02

1.12 Find $\delta^*(A, 00122)$ in the $NFA-\epsilon$ below.



02

1.13 If the binary operation $*$ is associative then find X and Y in the following table.

$*$	a	b	c	d
a	a	b	c	d
b	b	a	c	d
c	c	X	Y	d
d	d	c	c	d

01

1.14 Let $E: 2^3 \rightarrow 2^9$ be the encoding function for the (9,3) triple repetition code. If $D: 2_2^9 \rightarrow 2_2^3$ is the corresponding decoding function by applying D, decode the received word 111101100. 01

1.15 The encoding function $E: z_2^2 \rightarrow z_2^5$ is given by the generator matrix G as below:

$G = \begin{bmatrix} 1 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 1 & 1 \end{bmatrix}$. Find the associated parity check matrix H. 02

PART-B

2 a How many solutions are there to the equation $x_1 + x_2 + x_3 + x_4 + x_5 + x_6 = 29$, where $x_i\,; i = 1,2,\ldots 6$ is a non-negative integer such that.

i) $x_i > 1 \; for \; i = 1,2,3,4,5,6$?

ii) $x_1 \geq 1, x_2 \geq 2, x_3 \geq 3, x_4 \geq 4, x_5 > 6, x \geq 6$?

iii) $x_1 \leq 5$?

iv) $x_1 < 8 \;\&\; x_2 > 8$? 04

b The sequence of Lucas numbers is defined by $l_o = 2, l_1 = 1$ and $l_n = l_{n-1} + l_{n-2}$ for $n = 2,3,4, \ldots\ldots$ prove that $f_n + f_{n+2} = l_{n+1}$ whenever n is a positive integer, where f_i and l_i are the i^{th} Fibonacci and i^{th} Lucas number respectively. 06

c Solve the recurrence relation $a_{n+2} - 6a_{n+1} + 9a_n = 3(2^n) + 7(3^n)$, where $n \geq 0$ and $a_o = 1$ and $a_1 = 4$. 06

3 a State and prove the following rules of inference.

i) Law of syllogism

ii) Rule of destructive dilemma 06

b Let $P(x), q(x)$ and $r(x)$ be the following open statements: $P(x): x^2 - 7x + 10 = 0, q(x): x^2 - 2x - 3 = 0, r(x): x < 0$. Determine the truth or falsity of the following statements where the universe is all integers. If the statement is false provide a counter example or explanation.

i) $\forall x(p(s) \rightarrow \sim r(x))$

ii) $\exists\, x\,(p(x) \rightarrow r(x))$

iii) $\exists\, x(q(x) \rightarrow r(x))$

iv) $\forall x\,(q(x) \rightarrow r(x))$ 04 c Show that the argument $h \to i, (h \wedge i) \to j, \sim k \to (h \vee i),$ $(j \vee \sim j) \to (i \to h) \vdash j \vee k$.

OR

4 a Establish the validity of the following argument. 06

$\forall x[p(x) \vee q(x)]$

$\exists x \sim p(x)$

$\forall x[\sim q(x) \vee r(x)]$

$\forall x[s(x) \to \sim r(x)]$

$\therefore \forall x \sim s(x)$

b Let $p(x), q(x) and\ r(x)$ be the following open statements $p(x): |x| > 3, q(x): x > 3$ and $r(x): x < -3$. Write the converse inverse and contrapositive of the implication $\forall x\,(p(x) \to (r(x) \vee q(x)))$. 06

c Express each of the following statements in equivalent predicate logic formula. What is their negation? 04

i) All humming birds are richly colored.

ii) No large birds live on honey.

iii) Birds that do not live on honey are dull in color

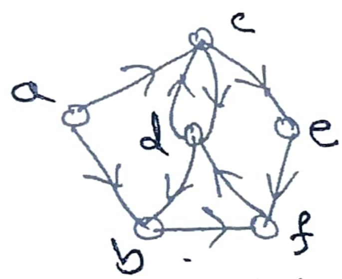
iv) Humming birds are small. 06

5 a Let R be a relation on Z such that aRb iff $ab > 0$ for all $a, b \in Z$. Verify whether R is an equivalence relation. 04

b Let R be the relation whose digraph is given below.

i) Draw digraph of R^3.

ii) Write M_R^6.



06

c Let $f, g, h : z \to z$ defined by $f(x) = x - 1, g(x) = 3x, h(x) = \begin{cases} 0, x\ even \\ 1, x\ odd \end{cases}$. 06

Determine fog , hog, fo(goh) and h^3.

OR

6 a Define $POSET$. Draw the Hasse diagram representing the partial ordering $\{(a,b)|a\ divides\ b\}$ on the set $\{1,2,3,6,12,24,36,48\}$. Find the lower bounds, upper bounds, GLB, LUB for the sets $\{2,6,12\}$ and $\{12,36,48\}$. 05

b Let $f: R \to R$ determine whether f is invertible and if so determine f^{-1} where $f_1 = \{\ (x,y)/\ 2x + 3y = 7\}$. 05

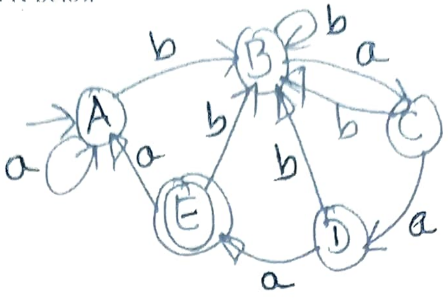
c Let $A = \{1,2,3,4,5,6,7\} and\ B = \{v, w, x, y, z\}$. Determine the number of functions $f: A \to B$ where

i) $|f(A)| = 2$

ii) $f(A) = \{w, x, y\}$ 06

iii) $|f(A)| = 4$

a Consider the DFA below



i) What is the language of DFA?

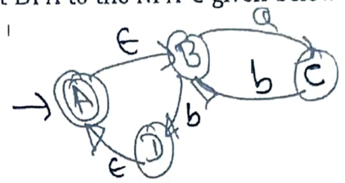
ii) Find $\delta^*(A, ababaaa)$ & $\delta^*(A, ababaaba)$. 04

b Construct NFA which accepts the following language over $\Sigma = \{0,1\}$.

i) Set of all strings ends with 01 *or* 10

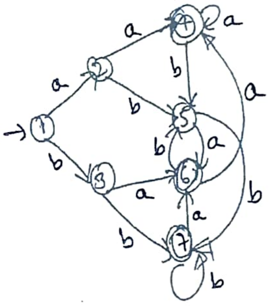
ii) Set of all strings consists of 101 as a substring. 04

c Find the equivalent DFA to the NFA-ϵ given below



04

d If possible to minimize the states , find the minimum state DFA for the given DFA.



04

8 a Define the binary operation $*$ *on* Z by $x * y = x + y + 1$. Verify that $(z,*)$ is an abelian group. 04

b Find all subgroups of $(z_{18}, +)$. 04

c Prove that if f is an isomorphism from G_1 *to* G_2, then f^{-1} is an isomorphism from G_2 *to* G_1. 04

d The encoding function $E: Z_2^2 \to z_2^5$ is given by the generator matrix $G = \begin{bmatrix} 1 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 1 & 1 \end{bmatrix}$. Determine all the code words. Find the associated parity check matrix H. Use H to decode the received words 00111, 00110. 04

SCHEME AND SOLUTION

SUBJECT CODE: 12CS36. **SUBJECT:** Discrete Mathematical Structures.(12CS36

Question No		Marks
1 1.1	$P(8,5) = 8!/(8-5)! = 8!/3! = \underline{6720}$	01
1.2	let $x = 2a$, $y = -3b$ $\therefore (2a-3b)^7 = (x+y)^7$. $\therefore$ coefficient of x^5y^2 in $(x+y)^7$ is $\binom{7}{5}x^5y^2$ $\Rightarrow \binom{7}{5}(2a)^5(-3b)^2 \Rightarrow \binom{7}{5}(2^5 - (-3)^2)a^5b^2 = 6048a^5b^2$. $\therefore$ co-efficient of $a^5b^2 = \underline{6048}$	02
1.3	Definition: given a set A, construct the set P(A) consisting of all subsets of A. The obtained set is called as power set of A and denoted by P(A) $\underline{P(A)} = \{\emptyset, \{0, \emptyset, \{\emptyset\}\}$ $\{0\}, \{\emptyset\}, \{\{\emptyset\}\}$ $\{0, \emptyset\}, \{\emptyset, \{\emptyset\}\}, \{0, \{\emptyset\}\}\}$ $2^{\lvert A \rvert} = 2^3 = \underline{8}$ elements. or subsets.	02 Def=01 P(A)=01
1.4	given $P = \{(A \cap B) \cap \emptyset\} \cup \{(C \cap D) \cup U\}$ Duality= $P^d = \{(A \cup B) \cup U\} \cap \{(C \cup D) \cap \emptyset\}$. '$\cap$' Replaced by '$\cup$', $\emptyset$ Replaced by U '$\cup$' " $\cap$ U " " $\emptyset$	01
1.5	Ans: $a_1 = 3$ and $a_{n+1} = a_n + 2n + 3$ for $n \geq 1$	02
1.6	p q r $(q \vee r)$ $p \to (q \vee r)$ 1 1 1 1 1 1 0 1 1 1 1 0 1 1 $p \to (q \vee r)$ is true in all three cases.	01=for Truth table. 01=for Checking the truth values

SCHEME AND SOLUTION

SUBJECT:

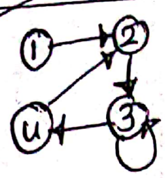
SUBJECT CODE:

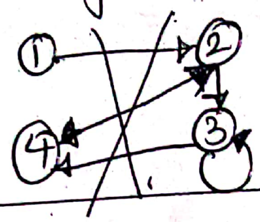
Question No		Marks
1.7	The law of negation of a conditional is as follows: $\neg(p \to q) \Leftrightarrow [p \wedge (\neg q)]$	01
1.8	see below	01 02
1.9	see below	01+
1.10	see below	01

1.8

Vertex.	Indegree,	Outdegree
1	0	1
2	2	1
3	2	2
4	1	1

Diagraph.





1.9 ~~Let~~ $M_R = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$

1.10 Identity element

$x \bullet e = e \bullet x = x$ for all $x \in Z$

$\therefore x \bullet (-1) = (-1) \bullet x = x$

$\therefore x + (-1) + 1 = (-1) + x + 1 = x$

$\therefore x = x = x$ $\therefore$ $\underline{-1 \text{ is the}}$ identity element.

Inverse element.

$x \bullet (x^{-1}) = (x^{-1}) \bullet x = e$ for all $x \in Z$.

$\therefore x + x^{-1} + 1 = x^{-1} + x + 1 = e$

$\therefore x + x^{-1} + 1 = e$ & $x^{-1} + x + 1 = e$

$\therefore x + x^{-1} + 1 = -1$ & $x^{-1} + x + 1 = -1$

$\therefore x^{-1} = -1 - 1 - x$ $\quad x^{-1} = -1 - x - 1$

$\therefore x^{-1} = -(x+2)$ & $x^{-1} = -(x+2)$

$\therefore$ $\underline{-(x+2) \text{ is inverse element}}$

SCHEME AND SOLUTION

SUBJECT CODE: 12CS36 **SUBJECT:** Discrete Mathematical Structures.

Question No		Marks
1.11	$S(5,3) = 25$ it is Stirling number of second kind Solution: $P(5,3) = \sum_{k=0}^{3} (-1)^k \, 3C_{3-k} \, (3-k)^5$ $= (-1)^0 . 3C_3 . 3^5 + (-1)^1 . 3C_2 . 2^5 + (-1)^2 3C_1 . 1^5$ $= 243 - 96 + 3$ $= 150$ $\therefore S(m,n) = P(m,n)/n! = 150/6 = \underline{\underline{25}}$	02
1.12	given $c = 1010110$, $e = 010101$ $r = c + e = (1,0,1,0,1,1,0) + (0,1,0,1,1,0,1)$ $= (1+0, 0+1, 1+0, 0+1, 1+1, 1+0, 0+1)$ $= (1,1,1,1,0,1,1)$ using addition Rule in Z_2. $\therefore r = \underline{1111011}$	01
1.13	11100, weight is 03 01101, " " 03.	01
	PART B.	
2 a.	Possible arrangements of letters in MASSASAUGA $= \dfrac{10!}{4!3!1!1!1!}$ $= 25200$ ways. " " " Number 4, A's $= \dfrac{7!}{4!3!1!1!1!} = 840.$	2.5 2.5
b.	let $\lvert U \rvert = 52$, $\lvert A \rvert = 30$, $\lvert B \rvert = 28$, $\lvert A \cap B \rvert = 13$ $\therefore$ By addition Principle $\lvert A \cup B \rvert = \lvert A \rvert + \lvert B \rvert - \lvert A \cap B \rvert = 30 + 28 - 13 = \underline{\underline{45}}$ & $\lvert \overline{A \cup B} \rvert = \lvert U \rvert - \lvert A \cup B \rvert = 52 - 45 = \underline{\underline{7}}$ 45 students study at least one of the two languages & 7 " " neither of these languages.	05

c. Binomial theorem:- Theorem should be written & explained. (05 marks)

SCHEME AND SOLUTION

SUBJECT CODE: 12CS36 . **SUBJECT:** Discrete Mathematical Structures

Question No		Marks
3.a.	Rook polynomial is $1+6x+10x^2+6x^3$	05
b.	obtain the formula - theory & steps should be written to get the formula.	05
c	$d_4=9$, & $4!-9=15$. permutations of 1,2,3,4 are not derangements.	05
4a.	let $S(n): a_n \le 3^n$. Basis step: $a_0=1\le 3^0$, $a_1=2\le 3^1$, $a_2=3\le 3^2$ $\therefore$ $(S(n))$ is true for $n=0,1,2$. Induction step: Assume $S(n)$ is true for $n=0,1,2..k$ where $k\geq 2$, $\therefore$ we note that. $a_{k+1} = a_k + a_{k-1} + a_{k-2}$ $\le 3^k + 3^{k-1} + 3^{k-2}$ $\because$ $S(k), S(k-1), S(k-2)$ & $S(k-3)$ are true by assumption. $\le 3^k + 3^k + 3^k$ $= 3\times 3^k = 3^{k+1}$ $\therefore$ $S(k+1)$ is true. Hence Proved	06
b.	$L_2=3$, $L_3=4$, $L_4=7$, $L_5=11$, $L_6=18$, $L_7=29$, $L_8=47$, $L_9=76$	05
c.	~~Find~~ explicit formula for i) $a_1=5$, $a_{n+1}=a_n+2$ for $n\geq 1$ ii) $a_1=3$, $a_n=a_{n-1}+3$ for $n\geq 2$	05
	OR	
5a	generating function $= f(x) = (x^3+x^4+\dots+x^8)^4$. final answer is 125 ways.	06
5b	Ackermann's numbers are defined recursively for $m,n \in N$ as follows. $A_{0,n} = n+1$ for $n\geq 0$ $A_{m,0} = A_{m-1,1}$ for $m>0$ $A_{m,n} = A_{m-1,p}$ for $p = A_{m,n-1}$ $(m,n>0)$ & . $A_{1,3}=5$ $A_{2,3}=9$	05

SUBJECT: Discrete Mathematical structures.

Q.NO | | Marks.

5.6 The relation is recurrence relation, & can be solved by substituting the varying values of $n \geq 0$. ie $= n = 0, 1, 2, 3, 4, \ldots$ — 05

6a. Truth table must be constructed & for all the ~~truth~~ values of p, q, r, the truth value of the given compound proposition $[(p \to q) \wedge (q \to r)] \to (p \to r)$, should be 1. Then its a tautology — 06

6b Proof must be provided using laws of logic ~~or~~ and also using Truth tables. — 05 (2.5+2.5)

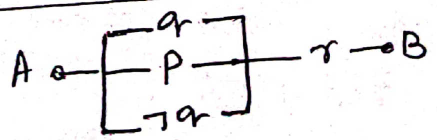
6c (i) $p \to (q \to r) \Leftrightarrow (p \wedge q) \to r$ — ~~(3)~~ (5) 2.5+2.5

$$LHS = p \to (q \to r) \Leftrightarrow \neg p \vee (\neg q \vee r)$$
$$\Leftrightarrow (\neg p \vee \neg q) \vee r$$
$$\Leftrightarrow \neg (p \wedge q) \vee r$$
$$\Leftrightarrow (p \wedge q) \to r \text{ - RHS.}$$

(ii) $[\neg p \wedge (\neg q \wedge r)] \vee (q \wedge r) \vee (p \wedge r) \Leftrightarrow r$

$$\Leftrightarrow \{r \wedge [\neg (p \vee q)]\} \vee \{r \wedge (p \vee q)\}$$
$$\Leftrightarrow r \wedge \{[\neg (p \vee q)] \vee (p \vee q)\}$$
$$\Leftrightarrow r \wedge T_0$$
$$\Leftrightarrow r.$$

7a. Switching network: — 05 (1+2+1)



Simplification: $(q \vee p \vee \neg q) \wedge r \Leftrightarrow \{(q \vee \neg q) \vee p\} \wedge r$

$$\Leftrightarrow (T_0 \vee p) \wedge r \quad \text{by inverse law}$$
$$\Leftrightarrow T_0 \wedge r \quad \text{by domination law}$$
$$\Leftrightarrow r \quad \text{by identity law.}$$

Simplified switching circuit A —r— B

ie, B not exists.

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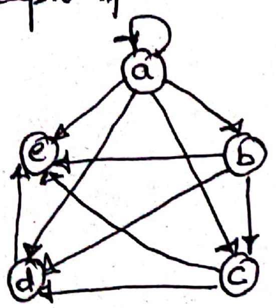
SCHEME and SOLUTION.

SUBJECT CODE : 12CS36 SUBJECT : DISCRETE MATHEM

Q NO.		
7.b.	Let $P(x)$: x has equal sides $r(x)$: x has two equal angles. $q(x)$: x is isosceles. Let c is triangle ABC.	06
	∴ The argument is. $\forall x, [P(x) \to q(x)]$ $\forall x, [q(x) \to r(x)]$ $\neg r(c)$ ———— $\therefore \neg P(c)$	
	We note that. $\{\forall x, [P(x) \to q(x)]\} \wedge \{\forall x, [q(x) \to r(x)]\} \wedge \neg r(c)$	
	$\Rightarrow \{\forall x, [P(x) \to r(x)]\} \wedge \neg r(c)$	
	$\Rightarrow \{P(c) \to r(c)\} \wedge \neg r(c)$ by Rule of Universal specification	
	$\Rightarrow \neg P(c)$ by Modus-Tollens Rule. Hence the argument is proved.	
7.c	(i) For any integer x if x is a perfect square then $x > 0$. = false.	05
	(ii) For some integer x, x is divisible by 3 and x is not even. = True	
	(iii) For any integer x, x is not a perfect square - false	
	(iv) For any integer x, x is a perfect square or x is divisible by 7 - False	
8a.	$f(A_1) = \{w\}$ $f(A_2) = \{w, x\}$, $f(A_3) = \{w, x\}$ $f(A_4) = \{x\}$, $f(A_5) = \{x, y\}$	05
b.	$f(0) = 1$, $f(-1) = 4$, $f(5/3) = 0$, $f^{-1}(-3) = \phi$, $f^{-1}(-6) = \phi$	05

No.		Marks
8c.	$f\circ(g\circ h)(x) = f\{(g\circ h)(x)\}$ $= f\{3h(x)\}$ $= 3h(x)-1$ $= \begin{cases} -1 & \text{if } x \text{ is even} \\ 2 & \text{if } x \text{ is odd.} \end{cases}$ & $(f\circ g)(x) = f\{g(x)\} = g(x)-1 = 3x-1$ $\therefore \{(f\circ g)\circ h\}(x) = (f\circ g)\{h(x)\}$ $= 3h(x)-1$ $= \begin{cases} -1 & \text{if } x \text{ is even} \\ 2 & \text{if } x \text{ is odd.} \end{cases}$ $\therefore$ Hence Proved.	06 (3+3)

OR

9a	$R^{\infty} = \{(a,a),(a,b),(a,c),(a,d),(a,e)$ $(b,c),(b,d),(b,e),(c,d),(c,e),(d,e)\}$ Digraph of R^{∞}  $M_{R^{\infty}} = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$	(06) 2+2+2
b.	R is not Reflexive, Hence not equivalence relation, for nature of not a partial ordered relation, the answer should consists of all relations, the answer should consists of all the six properties.	(5) 2+1+1
c.	The answer should consists of only extremal elements related to subset B_1. 1) Upper bounds of B_1 = 3,4,5,6,7,8. 2) $LUB(B_1) = 3$. 3) lower bounds of B_1 = None $GLB(B_1)$ = None. The not a lattice as GLB not exists.	(5) 1+1+1+1

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Sheme & Solution.

subject code : 12CS36 Subject : Discrete Mathema[tics]

Q NO		Marks
10 a)	Let $W_4 = \{1, -1, i, -i\}$ is a set of fourth root of Unity.	05
b)	$(\alpha\beta)^{-1} = \beta^{-1}\alpha^{-1}$ – to be proved	05
c)	From multiplication table.	05
11 a)	Probability that c is received as r is.	5 (2.5 + 2.5)
b)	Complete definition & explaination of decoding & encoding of message is to be written, with relevant notations	6 (3+3)
c)	Decoded words are as follows.	5 (Each 1 mark, formula 1 mark)

10 a) Let $W_4 = \{1, -1, i, -i\}$ is a set of fourth root of Unity.

The operation table is

×	1	−1	i	−i
1	1	−1	i	−i
−1	−1	1	−i	i
i	i	−i	−1	1
−i	−i	i	1	−1.

1) w is closed, associative, commutative.
2) Identity element = 1
3) Every element A has inverse.

Hence its an abelian group.

b) $(\alpha\beta)^{-1} = \beta^{-1}\alpha^{-1}$ – to be proved

$\alpha\beta = \begin{pmatrix}1&2&3&4\\2&4&3&1\end{pmatrix}\begin{pmatrix}1&2&3&4\\4&2&1&3\end{pmatrix} = \begin{pmatrix}1&2&3&4\\1&4&2&3\end{pmatrix}$ & $(\alpha\beta)^{-1} = \begin{pmatrix}1&2&3&4\\1&3&4&2\end{pmatrix}$

$\alpha^{-1} = \begin{pmatrix}1&2&3&4\\4&1&3&2\end{pmatrix}$ $\beta^{-1} = \begin{pmatrix}1&2&3&4\\3&2&4&1\end{pmatrix}$, $\beta^{-1}\alpha^{-1} = \begin{pmatrix}1&2&3&4\\1&3&4&2\end{pmatrix}$

$\therefore (\alpha\beta)^{-1} = \beta^{-1}\alpha^{-1}$.

c) From multiplication table.

$b^2 = b * b = c$, $b^3 = b^2 * b = c * b = d$

$b^4 = b^3 * b = d * b = e$, $b^5 = b^4 * b = e * b = f$.

$b^6 = b^5 * b = f * b = a$.

Every element of g is an integral power of b $\therefore (g, *)$ is a cyclic group with b as generator

OR.

11 a) Probability that c is received as r is.

$p^2(1-p)^{7-2} = (0.02)^2(1-0.02)^5 = 0.00036$.

The error pattern is. $r = c + e$, by component wise addition, the pattern is – $e = e_1e_2e_3e_4e_5e_7 = 0001001$

b) Complete definition & explaination of decoding & encoding of message is to be written, with relevant notations

c) Decoded words are as follows.

$D(11110100) = 101$ $D(01001111) = 011$

$D(000100011) = 000$ $D(00111001) = 011$