

Duration: - 3 Hours

Marks: 80 Marks

NB: - Question 1 is compulsory

Solve any three questions from the remaining.

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|-----|--|----|
| 1 | a) Convert decimal number 576.24 into binary, base-9, octal, hexadecimal system. | 04 |
| | b) Construct hamming code for 1010 using odd parity. | 04 |
| | c) Convert $(-89)_{10}$ to its equivalent Sign Magnitude, 1's Complement and 2's Complement Form | 04 |
| | d) Perform $(BC5)_H - (A2B)_H$ without converting to any other base | 04 |
| | e) Prove De Morgans theorem | 04 |
| 2a. | Given the logic expression: $A + \overline{B}C + AB\overline{D} + ABCD$
1. Express it in standard SOP form.
2). Draw K-map and simplify.
3). Draw logic diagram using NOR gates only. | 10 |
| 2b. | Reduce using Quine McClusky method & realize the operation using only NAND gates.
$F(A,B,C,D) = \prod M(0, 2, 3, 6, 7, 8, 9, 12, 13)$. | 10 |
| 3a. | Design a 4-bit binary to gray code converter. | 10 |
| 3b. | Design a 4-bit BCD adder using IC 7483 and necessary gates. | 10 |
| 4a. | Implement the following logic function using all 4:1 multiplexers with the select inputs as 'B', 'C', 'D', 'E' only.
$F(A,B,C,D,E) = \sum m(0, 1, 2, 3, 6, 8, 9, 10, 13, 15, 17, 20, 24, 30)$ | 10 |
| 4b. | Convert a SR flip flop to J K flip flop | 10 |
| 5a. | Design a mod-6 synchronous counter using T FF | 10 |
| 5b. | Explain the operation of 4-bit universal shift register. | 10 |
| 6 | Write short notes on any two | 20 |
| a. | VHDL | |
| b. | TTL and CMOS logic families | |
| c. | 4-bit Magnitude comparator | |
| d. | 3 to 8 line decoder | |

(3 Hours)

[Total Marks: 80]

N.B (1) Question No. 1 is compulsory.

- (2) Solve any **three** questions out of remaining **five** questions.
- (3) Assumptions made should be clearly stated.
- (4) Figures to the right indicate full marks.

Q.1 (a) Two dice are rolled, find the probability that the sum is [6M]
 (i) Equal to 1 (ii) Equal to 4 (iii) Less than 13

(b) Use the laws of logic to show that [6M]
 $[(p \rightarrow q) \wedge \sim q] \rightarrow \sim p$ is a tautology

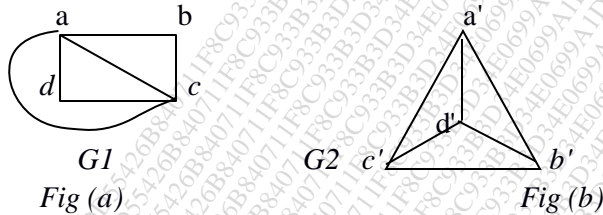
(c) Determine the matrix of the partial order of divisibility on the set A. Draw the Hasse diagram of the Poset. Indicate those which are chains [8M]

- (1) $A = \{1, 2, 3, 5, 6, 10, 15, 30\}$
- (2) $A = \{3, 6, 12, 36, 72\}$

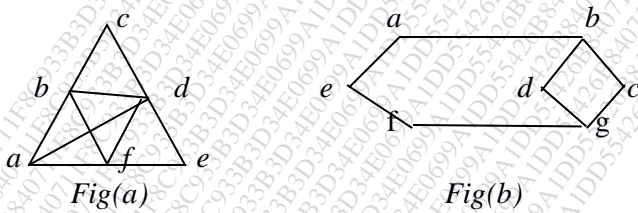
Q.2 (a) Find the complement of each element in D_{42} . [6M]

(b) Let Q be the set of positive rational numbers which can be expressed in the form $2^a 3^b$, where a and b are integers. Prove that algebraic structure (Q, \cdot) is a group. Where \cdot is multiplication operation. [6M]

(c) Define isomorphic graphs. Show whether the following graphs are isomorphic or not. [8M]



Q.3 (a) Determine which of the following graph contains an Eulerian or Hamiltonian circuit. [6M]



(b) For all sets A, X and Y show that [6M]
 $A \times (X \cap Y) = (A \times X) \cap (A \times Y)$

(c) Let $f(x) = x+2$, $g(x) = x-2$ and $h(x) = 3x$ for $x \in \mathbb{R}$, Where \mathbb{R} = Set of real numbers. Find [8M]
 $(g \circ f)$, $(f \circ g)$, $(f \circ f)$, $(g \circ g)$, $(f \circ h)$, $(h \circ g)$, $(h \circ f)$, $(f \circ h \circ g)$

Q.4 (a) Let R is a binary relation. Let $S = \{(a, b) \mid (a, c) \in R \text{ and } (c, b) \in R \text{ for some } c\}$ Show that if R is an equivalence relation then S is also an equivalence relation. [6M]

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(b) Determine the generating function of the numeric function a_r , where [6M]

(i) $a_r = 3^r + 4^{r+1}, r \geq 0$

(ii) $a_r = 5, r \geq 0$

(c) Consider the (3, 6) encoding function $e: B^3 \rightarrow B^6$ defined by [8M]

$e(000) = 000000$ $e(001) = 001100$ $e(010) = 010011$ $e(011) = 011111$

$e(100) = 100101$ $e(101) = 101001$ $e(110) = 110110$ $e(111) = 111010$

Decode the following words relative to a maximum likelihood decoding function.

- (i) 000101 (ii) 010101

Q.5 (a) Determine the number of positive integers n where $1 \leq n \leq 100$ and n is not divisible by 2, 3 or 5. [6M]

(b) Use mathematical induction to show that $1+5+9+\dots+(4n-3) = n(2n-1)$ [6M]

(c) Find the greatest lower bound and least upper bound of the set $\{3, 9, 12\}$ and $\{1, 2, 4, 5, 10\}$ if there exists in the poset $(z, /)$. Where $/$ is the relation of divisibility. [8M]

Q.6 (a) Let $A = \{1, 2, 3, 4\}$ and Let $R = \{(1,1) (1,2) (1,4) (2,4) (3,1) (3,2) (4,2) (4,3) (4,4)\}$. Find transitive closure by Warshall's algorithm. [6M]

(b) Let $H = \{[0]_6, [3]_6\}$ find the left and right cosets in group Z_6 . Is H a normal subgroup of group of Z_6 . [6M]

(c) Find the complete solution of the recurrence relation $a_n + 2a_{n-1} = n+3$ for $n \geq 1$ and with $a_0 = 3$ [8M]

(3 Hours)

(Total Marks: 80

- N.B. :** 1. Question **ONE** is compulsory.
 2. Solve any **THREE** out of remaining questions.
 3. **Draw neat and clean diagrams.**
 4. Assume suitable **data** if required.

Q. 1. A. Explain the concept and significance of CMRR and Slew Rate in case of op-amps. **5**

B. Given $\beta=120$ and $I_E= 3.2 \text{ mA}$ for a common-emitter configuration with $r_0=\infty \Omega$, determine:

(a) Z_i

(b) A_v if a load of $2 \text{ k}\Omega$ is applied.

(c) A_i with the $2 \text{ k}\Omega$ load. **5**

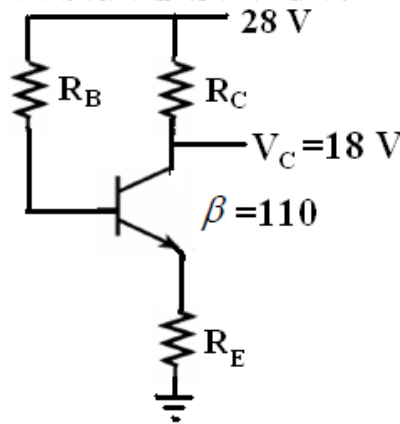
C. Discuss the factors that influence modulation index of an FM wave. **5**

D. Justify that adaptive delta modulation superior to delta modulation. **5**

Q. 2 A. The emitter bias configuration as shown in following figure has the specifications:

$$I_{CQ} = \frac{1}{2} I_{Csat} \quad I_{Csat} = 8 \text{ mA} \quad V_C = 18 \text{ V} \quad \text{and} \quad \beta = 110$$

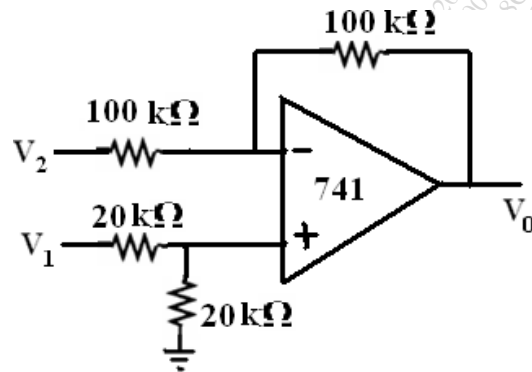
Determine R_C , R_E and R_B . **10**



B. Explain how op-am can be used comparator and zero crossing detector. **10**

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- Q. 3 A. What is the source of the leakage current in a transistor?
 If the emitter current of a transistor is 8 mA and I_B is $1/100$ of I_C , determine the levels of I_C and I_B . 5
- B. Draw and explain Colpitts oscillator. 5
- C. Explain principle of FDM. 5
- D. Determine the output voltage for the circuit if $V_1=5V$ and $V_2=3V$



- Q. 4 A. What is DSBSC wave and explain its generation using balanced modulator. 10
- B. What is multiplexing in communication system? Draw block diagram of TDM-PCM system and explain. 10
- Q. 5 A. State Shannon's theorem on channel capacity.
 What is the maximum capacity of a perfectly noiseless channel whose bandwidth is 120 Hz, in which the values of the data transmitted may be indicated by any one of the 10 different amplitudes? 10
- B. With respect to neat diagram explain the elements of analog communication system. 10
- Q. 6 A. What is meant by Nyquist rate in sampling and explain its significance. 5
- B. Give the proper definition for entropy and information rate. 5
- C. Write short note on op-amp as differentiator. 5
- D. Differentiate between Class A and Class C power amplifiers with respect to circuit diagram, operating cycle and power efficiency. 5

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NB 1. Question No.I is compulsory

2. Attempt any three from the remaining six questions
3. Figures to the right indicate full marks

Q1a If Laplace transform of $\operatorname{erf}(\sqrt{t}) = \frac{1}{s\sqrt{s+1}}$, then find $L\{e^t \operatorname{erf}(2\sqrt{t})\}$ [20]

b Find the Orthogonal Trajectory of the family of curves given by $e^{-x} \cdot \cos y + x \cdot y = c$

c Find Complex Form of Fourier Series for e^{2x} ; $0 < x < 2$

d. If the two regression equations are $5x - 6y + 90 = 0$, $15x - 8y - 180 = 0$,

find the means of x and y , the Correlation Coefficient and Standard deviation of x if variance of Y is 1

Q2 Show that the function is Harmonic and find the Harmonic Conjugate $v = e^x \cdot \cos y + x^3 - 3xy^2$ [6]

b Find Laplace Transform of $f(t) = \begin{cases} t & ; 0 < t < 1 \\ 0 & ; 1 < t < 2 \end{cases}$, $f(t+2) = f(t)$ [6]

c. Find Fourier Series expansion of $f(x) = x - x^2$, $-1 < x < 1$ [8]

Q3 a Find the Analytic function $f(z) = u + iv$ if $v = \log(x^2 + y^2) + x - 2y$ [6]

b Find Inverse Z transform of $\frac{3z^2 - 18z + 26}{(z-2)(z-3)(z-4)}$, $3 < |z| < 4$ [6]

c Solve the Differential Equation $\frac{d^2y}{dt^2} + 4y = f(t)$, $f(t) = H(t-2)$, $y(0) = 0$, $y'(0) = 1$ using Laplace Transform [8]

Q4 a Find $Z\{f(k) * g(k)\}$ if $f(k) = \left(\frac{1}{2}\right)^k$, $g(k) = \cos \pi k$ [6]

b Find the Spearman's Rank correlation coefficient between X and Y . [6]

X	60	30	37	30	42	37	55	45
Y	50	25	33	27	40	33	50	42

c Find the inverse Laplace transform of i) $\frac{3s+1}{(s+1)^4}$ ii) $\frac{e^{4-3s}}{(s+4)^{5/2}}$ [8]

Q5 a Find Inverse Laplace Transform using Convolution theorem $\frac{1}{(s-4)^2(s+3)}$ [6]

b Show that the functions $f_1(x) = 1$, $f_2(x) = x$ are Orthogonal on $(-1,1)$. Determine the constants a, b such that the function $f(x) = -1 + ax + bx^2$ is Orthogonal to both $f_1(x), f_2(x)$ on the $(-1,1)$ [6]

c Find the Laplace transform of i) $e^{-3t} \int_0^t t \sin 4t dt$ ii) $\int_0^\infty \frac{e^{-t} - e^{-2t}}{t} dt$ [8]

Q6 a Fit a second degree parabola to the given data [6]

X	1	1.5	2	2.5	3	3.5	4
Y	1.1	1.3	1.6	2	2.7	3.4	4.1

b Find the image of $\left|z - \frac{5}{2}\right| = \frac{1}{2}$ under the transformation $w = \frac{3-z}{z-2}$ [6]

c Find Half Range Cosine Series for $f(x) = x \sin x$ in $(0, \pi)$ and hence find $\frac{1}{1.3} - \frac{1}{3.5} + \frac{1}{5.7} - \dots = \frac{\pi-2}{4}$ [8]

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- N.B:
- (1) Question No. 1 is Compulsory
 - (2) Attempt any **three** questions of the remaining **five** questions
 - (3) **Figures** to the **right** indicate **full** marks
 - (4) Make suitable assumptions wherever necessary with proper justifications

1. (a) What are various operations possible on data structures? (05)
 (b) What are different ways of representing a Graph data structure on a computer? (05)
 (c) Describe Tries with an example. (05)
 (d) Write a function in C to implement binary search. (05)

2. (a) Use stack data structure to check well-formedness of parentheses in an algebraic expression. Write C program for the same. (10)

(b) Given the frequency for the following symbols, compute the Huffman code for each symbol. (10)

Symbol	A	B	C	D	E
Frequency	24	12	10	8	8

3. (a) Write a C program to implement priority queue using arrays. The program should perform the following operations: (12)
 - i. Inserting in a priority queue
 - ii. Deletion from a queue
 - iii. Displaying contents of the queue

(b) What are expression trees? What are its advantages? Derive the expression tree for the following algebraic expression: $(a + (b/c)) * ((d/e) - f)$ (08)

4. (a) Write a C program to represent and add two polynomials using linked list. (12)
 (b) How does the Quicksort technique work? Give C function for the same. (08)

5. (a) What is a doubly linked list? Give C representation for the same. (05)

(b) Given the postorder and inorder traversal of a binary tree, construct the original tree:
 Postorder: D E F B G L J K H C A (10)
 Inorder: D B F E A G C L J H K

(c) What is hashing? What properties should a good hash function demonstrate? (05)

6. (a) Given an array $int\ a[] = \{69, 78, 63, 98, 67, 75, 66, 90, 81\}$. Calculate address of $a[5]$ if base address is 1600. (02)

(b) Give C function for Breadth First Search Traversal of a graph. Explain the code with an example. (10)

(c) Write a C program to implement a singly linked list. The program should be able to perform the following operations: (08)

- (i) Insert a node at the end of the list
- (ii) Deleting a particular element
- (iii) Display the linked list
