(3 Hours) **[Total Marks : 80]**

N.B. : (1) Question No 1 is Compulsory.
(2) Attempt any three questions out of the remaining five.
(3) All questions carry equal marks.
(4) Assume suitable data, if required and state it clearly.

1 Attempt any FOUR [20]

a Calculate the entropy of the following symbols in bits/symbol and decit/symbol. The symbols are S_1, S_2, and S_3 with probabilities 0.6, 0.3 and 0.1 respectively.

b Determine VRC bit for the data sequence 11110011 and show that it can detect 1-bit error.

c Compare ISI and ICI

d Explain AWGN and matched filter

e Find the bandwidth for transmitting 120 bps using QPSK, 4-ary FSK, MSK,8-ary PSK, and 16-ary QASK

2 a Calculate the maximum capacity of a Gaussian channel with a bandwidth of 3 kHz and SNR of 30dB.If the bandwidth is doubled, calculate the new channel capacity. [10]

b Parity bits equations of a (6,3) linear block code are given below. Construct generator matrix, parity check matrix and implement encoder & decoder. [10]
$P_3 = D_3 + D_2 + D_1$, $P_2 = D_3 + D_2$, and $P_1 = D_2 + D_1$

3 a Implement (7,4) cyclic code encoder and decoder using the generator polynomial [10]
$G(x) = x^3 + x^2 + 1$

b Find 3-bit HRC and 3-bit checksum for the data 101011001111 and show that these codes can detect 3 continuous bit errors [10]

4 a Generator sequences of a convolutional encoder are given below. Calculate the impulse response of the encoder and sketch trellis diagram and using the trellis diagram determines the codeword for the input message 111. [10]
$g^{(1)} = 111$ and $g^{(2)} = 101$

	b	Sketch and compare NRZ unipolar, NRZ polar, NRZ Manchester and NRZ AMI formats in terms of bandwidth, power requirement, synchronization capability, DC level and polarity inversion error. Data sequence is 0011.	[10]
5	a	Find minimum variance Huffman code and Shannon-Fano code for the symbols S_1, S_2, S_3, S_4 and S_5 with probabilities 0.2, 0.1, 0.4, 0.2 and 0.1 respectively. Compare the efficiencies and variances of the generated codes.	[10]
	b	Sketch QPSK and offset-QPSK waveforms for the input message 00011011 and explain the advantage of offset-QPSK over QPSK.	[10]
6	a	Derive the PSD of BFSK, sketch the power spectrum and find the bandwidth.	[10]
	b	Find the error probability of 16-ary QASK using signal space representation and Euclidean distance.	[10]

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Duration: 3hrs **[Max Marks:80]**

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1 Attempt any FOUR [20]

a Find the DFT of x[n]={5, 6, 7, 8}. Using answer and not otherwise find DFT of x1[n]={8, 5, 6, 7}.

b Find the impulse response if the frequency response of the system is given as $H(e^{j\omega}) = e^{-j3\omega}(1 + 0.5\cos\omega - 0.95\cos 2\omega)$

c Realize the linear phase FIR filter given as $h[n] = \{1, -0.5, 0, 0.5, -1\}$ using minimum number of multipliers.

d For linear phase FIR filter, one of the zeros is at $0.2e^{j\frac{\pi}{3}}$. Find other compulsory zeros for Odd Symmetric FIR filter. Determine the transfer function.

e Compare FIR filters with IIR filters

2 a Find the DFT of a real sequence x[n] ={1, -2, 3, 5, 1, 3, -4, 2} using DIT FFT. [10]

b The second order IIR filter is defined as [10]

$$H(z) = \frac{1}{(1 - 0.95z^{-1} + 0.225\,z^{-2})}$$

Determine the shift of poles in direct form and cascade form realization if coefficients are represented by 3 bits.

3 a Determine the digital IIR digital filter from analog filter transfer function which is given as $H(s) = \frac{10}{(s^2+7s+15)}$ with T=0.02sec. using impulse invariant transformation method. [10]

b Find DFT of x1[n]={1, 4, 3, -2} and x2[n]={1, -2, 4, 5} using DIF FFT only once. [10]

4 a Design a digital filter with flat passband and flat stopband which satisfies following constraints using bilinear transformation method. Assume Ts=0.1s. [10]

$0.8 \leq |H(e^{j\omega})| \leq 1 \qquad 0 \leq \omega \leq 0.25\pi$

$|H(e^{j\omega})| \leq 0.2 \quad 0.65\pi \leq \omega \leq \pi$

b Find the output of the system having impulse response h[n]={2,1,2} for input sequence x[n]={1, -2, 4, 5, 3, 2, 2, 1, 5, 7, -3, -1, 4, 2} using Overlap-save Method (Assume N=6). [10]

5 a Design a digital FIR filter using Hanning window for M=7 for given specifications. [10]

$$H(e^{j\omega}) = \begin{cases} e^{-j3\omega} & ; \quad \frac{\pi}{8} \leq |\omega| \leq \frac{\pi}{4} \\ 0 & ; \quad \text{otherwise} \end{cases}$$

b Realize the filter function by lattice realization structure. [10]

$H(z) = 1 + \frac{3}{4}z^{-1} + \frac{1}{2}z^{-2} + \frac{1}{4}z^{-3}$

6 a Explain group delay and phase delay. [6]

b Explain how DTSP is used in echo cancellation process. [7]

c Write a short note on Limit cycle oscillations [7]

Duration: 3hrs [Max Marks:80]

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1		Attempt any FOUR	[20]
	a	1-bit 5 stage shift register	
	b	Explain the working of floating gate transistor in Flash memory.	
	c	For enhancement type NMOS transistor threshold voltage V_T=0.7V, μnCox =40 μA/V2, W = 30μm, L = 10 μm. Calculate I_D if for VGS = 2 , V_{DS}= 2V	
	d	Explain clock distribution in VLSI design.	
	e	Draw HLSM of soda dispenser machine	
2	a	Consider a CMOS inverter with following parameters: nMOS VTN = 0.6 V μnCox =60 μA/V2 (W/L)n = 8 pMOS VTp = -0.7 V μpCox =25 μA/V2 (W/L)p = 12 Calculate the V_{IL} and V_{TH}. The power supply voltage is VDD = 3.3 V.	[10]
	b	Explain pWell fabrication process with neat diagrams.	[10]
3	a	Realize SR flip flop using CMOS logic and draw its layout.	[10]
	b	Explain 6T SRAM with its read and write operation.	[10]
4	a	Realize the expression Y=A(B+C) D using the following logic style. 1. CMOS logic 2. Pseudo NMOS 3. Dynamic Logic 4. Domino Logic	[10]
	b	Implement the following 1. 3x3 Array multiplier 2. 4:1 mux using TG	[10]
5	a	Implement the following 1. 4 bit carry lookahead adder carry using dynamic logic 2. 8-bit carry bypass adder	[10]

b Draw 4 *4 bit NAND based array and NOR based array to store the following data in respective memory locations. [10]

Memory address	Data
1000	0101
0100	1101
0010	0010
0001	1011

6 a Design a 'serial FIR filter' using the RTL design process. Draw HLSM,FSM, interface and Datapath [10]

b Realize the expression Y = A+ BC (D+E) +F using CMOS logic. Find equivalent CMOS inverter for simultaneously switching of all input. Assume $(\frac{W}{L})p = 15$, $(\frac{W}{L})n = 10$ [10]

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Time: 3 hours Max. Marks: 80

Q1 **(20 Marks)**

A **Solve any One** **10 marks each**

1. A point charge Q_1= 300μC is located at P_1(1,-1,-3)m experiences a force F_{21}= $8a_x$-$8a_y$+$4a_z$ (N) due to a point charge Q_2 at P_2(3,-3,-2)m. Determine Q_2.
2. State and Explain Gauss's law with its proof.

Or

1. Derive Poisson's and Laplace's equations.
2. Point charges 5nC & -2nC are located at (2,0,4) & (-3,0,5) respectively. Determine force on 1nC pt charge located at (1,-3,7).Find electric field E at (1,-3,7).

B
1. In free space, V= $6xy^2z$ + 8. Find electric field intensity E and volume charge density ρ_v at point P (1, 2, -5).
2. Prove that E=-∇V.

Q2 **(20 Marks)**

A **Solve any One** **10 marks each**

Evaluate both sides of the divergence theorem for the field $\mathbf{D}$= $2xy\mathbf{a_x}$ + $x^2\mathbf{a_y}$ (C/m^2) and a rectangular parallelepiped formed by the planes x=0 to 1, y=0 to 2, z=0 to 3.

Or

A boundary exists at Z =0 between two dielectrics. ε_r=3 in region Z<0 and ε_r=5 in region Z>0. If the electric field in region Z<0 is E_1=-$20a_x$+$40a_y$+$100a_z$. Find electric fields in other medium.

B
1. State and Explain Biot-Savart Law.
2. Find the magnetic field intensity produced by an infinitely long filament carrying a current 2.5A. The filament lies on the z axis in free space with radius 0.3 meters.

Q3 **(20 Marks)**

A **Solve any One** **10 marks each**

Derive Maxwell's equation for time varying fields in point and integral form and explain its significance.

Or

Derive the expression for the Helmholtz equation.

B State Poynting theorem. Derive mathematical expression for the Poynting theorem and explain the meaning of each term.

Q4 **(20 Marks)**

A Define reflection coefficient and standing wave ratio in a transmission line. Obtain the values of reflection coefficient and standing wave ratio for short circuit, open circuit and matched load conditions.

B **Solve any one** **10 marks each**

A transmission line of characteristic impedance of Z_0=50Ω and length d=0.15λ is terminated into load impedance of Z_L=(25-j30) Ω. Find Γ_0, Z_{in} (d) and SWR.

Or

A transmission line having characteristic impedance of 50 Ω is terminated with an impedance of (25+j50)Ω. Find the following using the smith chart:

1. Reflection coefficient
2. VSWR
3. Input impedance of line whose length is 0.3λ
4. Return loss in dB

Time: 3 hours **Max. Marks: 80**

N.B. : 1) Question no. 1 is compulsory
2) Answer any 3 questions from remaining five questions

Q1 Answer any four questions

a. Explain Bayes theorem and total probability theorem. 05
b. Define joint distribution function. What are its properties? 05
c. Find the Binomial distribution if the mean is 4 and variance is 3. 05
d. Find the characteristic function of a random variable X with uniform distribution in [-1, 1] 05
e. List the properties of autocorrelation function and prove any two properties. 05

Q2 a. The joint pdf of R.V. X & Y is given as 10

$$f_{XY}(x,y) = c\, e^{-x}\, e^{-y} \quad ,0 < y < x < \infty$$
$$= 0 \text{ , elsewhere}$$

Find
i. c
ii. f(x) & f(y)
iii. f(x/y) & f(y/x)

b. A biased coin tossed till a head appears for the first time. What is the probability that the numbered required tosses are odd? 06
c. Show that $p(AUB)=P(A)+P(B)-P(A \cap B)$ 04

Q3 a. If X, Y are two independent exponential random variables with common parameter λ. find the pdf of (U, V) where U = X+Y and V = X-Y. Also find f (u) and f (v). 10
b. Find mean and variance of Gaussian distribution function with parameters N (0, 1). 10

Q4 a. Explain the central limit theorem 05
b. Define SSS process and WSS process 05
c. Random Process is given as X (t) = sin (wt+Y) Where Y is uniformly distributed over $(0,2\pi)$ and w is a constant. Verify that X (t) is WSS or not. 10

Q5 a. The joint probability distribution of X and Y is given by 10

$$P(X=x, Y=y) = \frac{x+3y}{24}$$ where x=1, 2 and y=1, 2. Find

i. Marginal distributions of x and y
ii. $P(X \le 2, Y \le 1)$
iii. $P(X \le 1)$

b. Two dimensional random variables (X, Y) has the following distribution 10

$$f_{XY}(x,y) = 2-x-y \ , \quad 0 \le x \le 1, 0 \le y \le 1$$
$$= 0 \text{ , elsewhere}$$

Find
i. E(XY)
ii. Cov (X, Y)

Q6 a. Prove that for a linear time invariant system, if the input is a WSS process, then output is also WSS Process. 10
b. From the following data, obtain the two regression equations. 10

Sales	91	97	108	121	67	124	51	73	111	57
Purchases	71	75	69	97	70	91	39	61	80	47

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Duration: 3 Hrs **[Max Marks:80]**

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1		Attempt any FOUR	[20]
	A	State the advantages of JPEG-2000 over JPEG –LS.	
	B	Explain motion compensation in detail.	
	C	Discuss different types of active and passive attacks.	
	D	Find (i) 2^{16} mod17 (ii) 2^{50}mod17 Using Fermat's little theorem.	
	E	Write different types of biometric authentications methods used for security.	
2	A	Consider a source with alphabet A= {a_1, a_2, a_3} with probability P(a_1)=0.6, P(a_2)=0.3, P(a_3)=0.1 respectively. Perform the arithmetic coding operation to generate tag for the sequence $a_2a_1a_3a_1$ and also decipher the tag to get back.	[10]
	B	Explain in detail about H.264 encoder and decoder.	[10]
3	A	Explain how DES algorithm is used for data encryption with necessary diagrams.	[10]
	B	Illustrate Diffie-Hellman key exchange algorithm with suitable example.	[10]
4	A	Discuss Chinese Remainder Theorem with example.	[08]
	B	Write short note on A-law and μ-law Companding standards.	[12]
5	A	How RSA Algorithm is used to secure the data, explain in detail with example.	[10]
	B	Discuss various types of transposition and substitution cipher with examples.	[10]
6	A	What do you mean by HASH and MAC functions. Explain with examples.	[10]
	B	Explain in detail how Intrusion Detection System is used to secure the system.	[10]
