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10EC52

Fifth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Digital Signal Processing

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define DFT and IDFT of a signal. Establish relation between DFT and Z-transform. **(06 Marks)**

b. Find the IDFT of x(k) = (24, -2j, 0, +2j) **(06 Marks)**

c. Find the 8-point DFT of the sequence x(n) = {1, 1, 1, 0}. **(08 Marks)**

2 a. State and prove the circular (i) Time-shift and (ii) Frequency – shift properties of an N-point sequence. **(06 Marks)**

b. Find the 4-point circular convolution of the sequences $x_1(n) = (1, 2, 3, 1)$ and $x_2(n) = (4, 3, 2, 2)$. **(04 Marks)**

c. Let x(k) be a 14-point DFT of length – 14 real sequence x(n). The first 8-samples of x(k) are given by x(0) = 12, x(1) = -1+3j, x(2) = 3+4j, x(3) = 1-5j, x(5) = 6+3j, x(6) = -2-3j, x(7) = 10. Find the remaining samples of x(k). Also evaluate the following :

i) x(0) ii) x(7) iii) $\sum_{n=0}^{13} x(n)$ iv) $\sum_{n=0}^{13} |x(n)|^2$ **(10 Marks)**

3 a. In the direct computation of N-point DFT of x(n), how many
i) Complex additions
ii) Complex multiplications
iii) Real multiplication
iv) Real additions and
v) Trigonometric functions, evaluations are required? **(10 Marks)**

b. Find the output y(n) of a filter whose impulse response h(n) ={ 1, 2, 3, 4} and the input signal to the filter is x(n) = { 1, 2, 1, -1, 3, 0, 5, 6, 2, -2, -5, -6, 7, 1, 2, 0, 1 } using overlap add method with 6-point circular convolution. **(10 Marks)**

4 a. What is chirp-z-transform? Mention its applications. **(04 Marks)**

b. Given x(n) = {1, 0, 1, 0}, find x(2) using Goertzel algorithm. **(06 Marks)**

c. Determine 8-point DFT of a signal x(n) using, Radix – 2 DIF-FFT algorithm, draw the signal flow graph. $x(n) = \{\underset{\uparrow}{0}, 0.707, 1, 0.707, 0, -0.707, -1, -0.707\}$ **(10 Marks)**

PART – B

5 a. For Analog Butterworth filter, derive an expression for order, cut off frequency for design of low pass filter. **(10 Marks)**

b. Design Butterworth filter for following specifications :
$0.8 \le Ha(s) \le 1$ for $0 \le F \le 1KHz$ and $|Ha(s)| \le 0.2$ for $F \ge 5KHz$ **(10 Marks)**

6 a. Realize an FIR filter given by $h(n) = \left(\frac{1}{2}\right)^n [u(n) - u(n-4)]$ using direct form – I. **(06 Marks)**

b. Obtain the direct form – I, direct form – II, cascade and parallel form realization for the following system.
$Y(n) = 0.75\ y(n-1) - 0.125y\ (n-2) + 6x(n) + 7x(n-1) + x(n-2)$. **(14 Marks)**

7 a. Write equations of any four different windows used in design of FIR filters. **(08 Marks)**

b. Design the symmetric FIR, low pass filter whose desired frequency response is given as,

$$H_d(w) = \begin{cases} e^{-jw\tau}, & \text{for } |w| \le w_c \\ 0, & \text{otherwise} \end{cases}$$

The length of the filter should be 7 and $w_c = 1$ radian/sample. Use rectangular window. **(12 Marks)**

8 a. Explain how analog filter is mapped on to a digital filter using impulse invariant method. **(08 Marks)**

b. Design a digital low pass filter to satisfy the following pass band ripple $1 \le H(j\Omega) \le 0$, for $0 \le \Omega \le 1404\pi$ rad/sec and stop band attenuation $|H(\Omega)| > 60$dB for $\Omega \ge 8268\pi$ rad/sec. sampling interval $T_s = \frac{1}{10^{-4}}$ sec. Use BLT for designing. **(12 Marks)**

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10EC53

Fifth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Analog Communication

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. A random variable has probability density function given by $f_X(x) = 2e^{-2x}$ for $x \geq 0$ find the probability that it will take a value between 1 and 3. **(05 Marks)**

b. Explain the mean, correlation and covariance functions. **(09 Marks)**

c. Explain the Gaussian process and also mention the properties of the Gaussian process. **(06 Marks)**

2 a. Explain the operation of the switching modulator with circuit diagram, and waveform. **(07 Marks)**

b. Explain the operation of the ring modulator with circuit diagram and relevant waveforms. **(08 Marks)**

c. With relevant diagram explain the operation of the coherent detection of DSBSC modulated waves. **(05 Marks)**

3 a. With relevant diagrams, explain the operation of the quadrature carrier multiplexing transmitter scheme and receiver scheme. **(08 Marks)**

b. Mention the advantages and disadvantages of the SSB system. **(05 Marks)**

c. With relevant diagram explain the operation of the phase discrimination method for generating an SSB modulated wave. **(07 Marks)**

4 a. Explain the importance of vestigial sideband modulation with the spectrum of the VSB modulated wave. **(05 Marks)**

b. With block diagram approach, explain the operation of the frequency division multiplexing system. **(08 Marks)**

c. Explain the operation of the super heterodyne receiver with relevant block diagram. **(07 Marks)**

PART – B

5 a. When a 50.4 MHz carrier is frequency modulated by a sinusoidal AF modulating signal, the highest frequency reached is 50.405 MHz. Calculate:
i) The frequency deviation produced.
ii) Carrier swing of the wave.
iii) Lowest frequency reached. **(05 Marks)**

b. With block diagram approach explain the operation of the indirect frequency modulation using Armstrong method briefly. **(09 Marks)**

c. Explain the method of generating direct FM using suitable circuit. And also write the relevant expressions. **(06 Marks)**

6 a. With circuit diagram, explain the operation of the balanced slope detector. Plot the characteristics of the same. **(07 Marks)**

b. With relevant block diagram, explain the operation of the FM stereo multiplexing system. **(08 Marks)**

c. Explain the linear model of phase locked loop with relevant expressions. **(05 Marks)**

7 a. Explain briefly on the following: i) Shot noise; ii) Thermal noise. **(06 Marks)**

b. A receiver with a noise figure of 10dB is fed by a low noise amplifier that has a gain of 60dB and a noise temperature of 80K. Calculate the noise temperature of the receiver and overall noise temperature. Assume temperature 25°C. **(06 Marks)**

c. Explain the cascade connection of two port networks with block diagram and relevant expressions. **(08 Marks)**

8 a. With block diagram approach explain the noise in DSBSC receivers with model of DSBSC receiver using coherent detection. **(06 Marks)**

b. Find the figure of merit when the depth of modulation is i) 100% ii) 50% iii) 30%. **(06 Marks)**

c. Explain the pre-emphasis and De-emphasis in frequency modulation with circuits and graphs. **(08 Marks)**

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10EC54

Fifth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Microwaves and Radar

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions, selecting atleast TWO questions from each part.*
2. Use of Smith chart is permitted.
3. Missing data, if any, may be suitably assumed.

PART – A

1 a. Derive equations for voltage and currents for a transmission line. **(08 Marks)**

b. The characteristic impedance of a certain line is $\neg 10 \lfloor -16° $, when frequency is 1 KHz. At this frequency the attenuation is 0.071 NP/km phase constant is 0.035 rads/km. Calculate resistance, inductance, capacitance for 1 km and also velocity of propagation. **(06 Marks)**

c. Determine the input impedance of a 200Ω line, 3/8 wavelengths long terminated in a 100Ω resistance, using smith chart. Also find k in magnitude and angle. **(06 Marks)**

2 a. What are the properties of wave guide? Obtain the expression for Hz in the case of T.E. waves applying all boundary conditions. **(08 Marks)**

b. The cut-off wave lengths of a rectangular waveguide was measured to be 8 cm and 4.8 cm when excited in TE_{10} and TE_{11} modes respectively. Determine the dimensions of the wave guide. **(06 Marks)**

c. Explain the working of a four port circulator. **(06 Marks)**

3 a. With a neat sketch explain how PIN diode acts as a switch. Find the expression for insertion loss. **(08 Marks)**

b. Explain RWH theory in GUNN diodes and give its constructional details. **(06 Marks)**

c. Calculate the operating frequency of a silicon based IMPATT diode with drift length of 2 μm and drift velocity of 10^7 cm/sec. **(06 Marks)**

4 a. Give the S–matrix representation for multiport network. Also explain the properties of S – matrix. **(08 Marks)**

b. What is an H-plane Tee junction? Derive its S-matrix. **(06 Marks)**

c. What are phase shifters? Explain a rotary precision phase shifter with a neat sketch. **(06 Marks)**

PART – B

5 a. Explain a magic Tee structure and its S-matrix. Also give its various applications. **(08 Marks)**

b. What are micro strip lines? Explain the field distribution with a neat sketch. **(06 Marks)**

c. A micro strip line is composed of zero thickness copper conductors on a substrate having $\epsilon_r = 8.4$, $\tan\delta = 0.0005$ and thickness and thickness 2.4 mm. If the line width is 1 mm and operated at 10 GHz. Calculate Z_0, the attenuation due to conductors and dielectric loss. **(06 Marks)**

6 a. Name the various types of RADAR. Derive the radar range equation. **(08 Marks)**

b. A 1 kW, 3 GHz radar uses single antenna with a gain of 30 dB. The receiver has noise band width of 1 KHz and noise factor of 5 dB. A target of echoing area of 10 m^2 at a range of 10 nautical miles is to be detected. Calculate the minimum S/N. **(06 Marks)**

c. Explain block diagram of a radar with a neat diagram and explain each block. **(06 Marks)**

7 a. Explain with a neat diagram the working of a coherent MTI radar. **(08 Marks)**

b. Explain the various applications of radar. **(06 Marks)**

c. Explain the need of delay line cancellers in MTI radars. Also give the characteristics of a single delay line canceller. **(06 Marks)**

8 a. Explain with a neat block diagram the working of a simple digital MTI signal processor. **(07 Marks)**

b. Explain the working of a moving target detector with block diagram. **(07 Marks)**

c. Explain with a neat block diagram the working of a pulse Doppler RADAR. **(06 Marks)**

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Fifth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Information Theory & Coding

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Derive an expression for average information content of long independent messages. **(04 Marks)**

b. Explain Mark off statistical model used to represent dependent information sources. **(04 Marks)**

c. Find H, G_1 and G_2 for the following model **(12 Marks)**

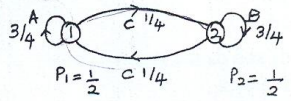
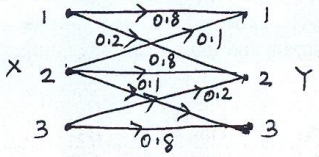


Fig Q1(c)

2 a. Apply Shannon's encoding Algorithm and generate binary codes for the set of messages given in table below. Also find efficiency. **(12 Marks)**

Sym	AA	BB	AC	CB	BC	CA	CC
Prob	9/32	9/32	3/32	3/32	3/32	3/32	2/32

b. Find H[X], H[Y], H[X Y], H[X/Y] and H[Y/X] for the channel shown below **(08 Marks)**



$P[X_1] = \frac{1}{3}$

$P[X_2] = \frac{1}{3}$

$P[X_3] = \frac{1}{3}$

Fig Q2(b)

3 a. A discrete memory less source has an alphabet of sever symbols with probabilities as given in the table below.

Sym	S_0	S_1	S_2	S_3	S_4	S_5	S_6
Prob	0.25	0.25	0.125	0.125	0.125	0.0625	0.0625

Compute Huffman code for this source by moving combined symbol as high as possible and as low as possible. Find efficiency and variance is each case. **(12 Marks)**

b. A non symmetrical binary channel is shown below :

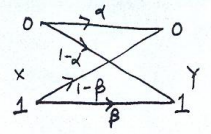


Fig Q3(b)

$P[x = 0] = \frac{1}{4}$

$P[x = 1] = \frac{3}{4}$

i) Find I [X Y] for $\alpha = 0.75$, $\beta = 0.9$

ii) Find C for $\alpha = 0.75$ and $\beta = 0.9$, rs = 1000sym/sec. **(08 Marks)**

4 a. State and prove Shannon's Hartely Law. **(10 Marks)**

b. A CRT terminal is used to enter alpha numeric data into a computer. The CRT is connected through a voice grade telephone line having usable bandwidth of 3KHz and O/P S/N of 10dB. Assume that the terminal has 128 characters which are equiprobable

i) Find channel capacity

ii) Maximum rate at which data can be transmitted without errors from the terminal to the computer. **(10 Marks)**

PART – B

5 a. The parity check bits of (8, 4) block code are generated by

$C_5 = d_1 + d_2 + d_4$

$C_6 = d_1 + d_2 + d_3$

$C_7 = d_1 + d_3 + d_4$

$C_8 = d_2 + d_3 + d_4$

Where d_1, d_2, d_3 and d_4 are message bits

i) Find G and H

ii) Find minimum weight of the code

iii) Find error detecting capacity

iv) Show thorough two examples that this code can detect and correct errors. **(10 Marks)**

b. Design a single error correcting code with a message block size of 11 bits and show by an example that the code can correct single errors. **(10 Marks)**

6 a. The generator polynomial of a (7, 4) cyclic code is $g(x) = 1 + x + x^3$. Find the code words for the following in both systematic and non systematic form, 1010, 1110, 0110, 1101. **(08 Marks)**

b. For a (15,5) binary cyclic code, generator polynomial is $g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}$. Draw the encoder diagram and find the encoded output for a message $D[x] = 1 + x^2 + x^4$. **(12 Marks)**

7 Write short notes on :

a. Golay codes.

b. Shortened cyclic codes

c. Burst error correcting codes

d. Burst and random error correcting codes. **(20 Marks)**

8 For a (3, 1, 2) convolutional encoder with generator sequences $g^{(1)} = 110$, $g^{(2)} = 101$, $g^{(3)} = 111$.

a. Find encoder block diagram **(02 Marks)**

b. Find generator matrix and O/P for 11101. **(02 Marks)**

c. Find code word for 11101 using time domain method. **(06 Marks)**

d. Draw state diagram and tree diagram. **(10 Marks)**

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10EC56

Fifth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Fundamentals of CMOS VLSI

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Explain the action of enhancement mode transistor for different values of V_{gs} and V_{ds}. **(08 Marks)**

b. Explain the second order effects viz.
(i) Focoler Nordheium Tunneling.
(ii) Drain punch through.
(iii) Impact ionization. **(06 Marks)**

c. Describe in detail CMOS fabrication in an P-well process. **(06 Marks)**

2 a. Draw schematic, stick diagram, layout for nMOS 2-input NOR gate, where 4 : 1 ratio for pull up and 1 : 1 ratio for each pull-down. Specify λ-based rules for layout. **(12 Marks)**

b. Provide the λ-based design rules for transistors, contact cuts and vias. **(08 Marks)**

3 a. Realize 2-input NAND gate as example in,
(i) BiCMOS logic.
(ii) Pseudo-nMOS logic.
Discuss merits and demerits. **(10 Marks)**

b. Explain the dynamic CMOS logic with example. List the problems and solution for issues. **(10 Marks)**

4 a. What are the scaling factor for:
(i) Gate capacitance
(ii) Maximum operating frequency
(iii) Current density
(iv) Power speed product. **(10 Marks)**

b. Define sheet resistance and standard unit of capacitance □Cg. Calculate the ON resistance for NMOS inverter with R_{SN} = 10 KΩ, Z_{PU} = 4 and Z_{pd} = 1, V = 5 V. And calculate power dissipiation. **(10 Marks)**

PART – B

5 a. Design a parity generator, where output is 1 for even number of one's and draw the stick diagram for one basic cell. **(10 Marks)**

b. In the circuit shown in Fig. Q5 (b). Find V_1, V_2, V_3, V_4. Assume threshold voltage of each transistor is V_{tn}. **(04 Marks)**

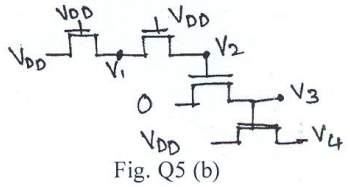

Fig. Q5 (b)

c. Draw the basic form of a 2-ϕ clock generator and explain. **(06 Marks)**

6	a.	Discuss the architectural issues to be followed in the design of a VLSI sub-system.	**(06 Marks)**
	b.	Realize a 4×4 barrel shifter using MOS switches and explain in brief.	**(06 Marks)**
	c.	Explain carry skip adder.	**(08 Marks)**
7	a.	Discuss the various system timing consideration.	**(04 Marks)**
	b.	Explain the 3T DRAM cell with stick diagram.	**(10 Marks)**
	c.	Describe the CMOS pseudo-static RAM circuit.	**(06 Marks)**
8	a.	Explain different types of Input/Output pads.	**(05 Marks)**
	b.	List the ground rules for a system design.	**(05 Marks)**
	c.	Write a note on Built-in self test.	**(05 Marks)**
	d.	Write a note on BiCMOS logic with neat circuit.	**(05 Marks)**

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10TE52

Fifth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Digital Signal Processing

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions, selecting atleast TWO questions from each part.*
2. Use of normalized Butterworth and Chebyshev tables are not allowed.

PART – A

1 a. Find the Z-transform of the sequence x(n) = {0.5, 0, 0.5, 0}. Using Z-transform result find its DFT. **(08 Marks)**

b. Find the 5-point DFT of x(n) = {1, 1, 1}. **(05 Marks)**

c. Find IDFT for the sequence : x(k) = {5, 0, (1 – j), 0, 1, 0, (1 + j), 0}. **(07 Marks)**

2 a. Given the 8-point sequence :

$$x(n) = \begin{cases} 1, & 0 \le n \le 3 \\ 0, & 4 \le n \le 7 \end{cases}$$

compute the DFT of the sequence $x_1(n)$ using properties of DFT :

$$x_1(n) = \begin{cases} 1, & n = 0 \\ 0, & 1 \le n \le 4 \\ 1, & 5 \le n \le 7 \end{cases}.$$ **(08 Marks)**

b. Let x(n) = {1, 2, 3, 4} with x(k) = {10, –2 + 2j, –2, –2 –2j}.
Find the DFT of $x_1(n)$ = {1, 0, 2, 0, 3, 0, 4, 0} using minimum number of operation. **(06 Marks)**

c. For the DFT pair shown, compute the values of the boxed quantities using appropriate properties.

($\boxed{x_0}$, 3, – 4, 0, 2) $\overset{\text{DFT}}{\longleftrightarrow}$ (5, $\boxed{x_1}$, –1.28 –j3.49, $\boxed{x_3}$, 8.78 –j1.4). **(06 Marks)**

3 a. Find the output y(n) of a filter whose impulse response is h(n) = {1, –2} and input signal x(n) = {3, –2, 4, 1, 5, 7, 2, –9} using overlap – add method. Use only 5 – point circular convolution in your approach. **(06 Marks)**

b. What is the need of FFT? Determine the following for a 128 point FFT computation number of : i) Stages ii) butter files in each stage iii) butter files needed for entire computation iv) total number of complex multiplications v) total number of complex additions. **(05 Marks)**

c. Given sequence $x_1(n)$ = {2, 1, 1, 2} and $x_2(n)$ = {1, –1, –1, 1} compute the circular convolution $x_1(n) \circledast_N x_2(n)$: for N = 4 use DIT – FFT algorithm. **(09 Marks)**

4 a. Determine 8-point DFT of the real sequence x(n) = {1, 2, 2, 2, 1, 0, 0, 0}. Use DIF–FFT algorithm. **(08 Marks)**

b. What is Geortzel algorithm? obtain DF–II realization of tow pole resonator for computing DFT. **(08 Marks)**

c. What is Chrip-z signal? What are the applications of Chrip-z signal? **(04 Marks)**

PART – B

5 a. Derive an expression for order and cut-off frequency of Butterworth lowpass filter. **(08 Marks)**

b. Design a Chebyshev analog lowpass filter that has –3dB cut-off frequency of 100 rad/sec and stop band attenuation of 25dB (or) grater for all radian frequencies past 250 rad/sec. Verify the design. **(12 Marks)**

6 a. Realize FIR linear phase filter for 'N' to be even. **(08 Marks)**

b. Obtain the cascade and parallel realizations of : $H(z) = \dfrac{1+\frac{1}{4}z^{-1}}{\left(1+\frac{1}{2}z^{-1}\right)\left(1+\frac{1}{2}z^{-1}+\frac{1}{4}z^{-2}\right)}$. **(12 Marks)**

7 a. A low pass filter has the desired frequency response :

$$H_d(\omega) = H_d(e^{j\omega}) = \begin{cases} e^{-j3\omega} & 0 < \omega < \pi/2 \\ 0, & \pi/2 < \omega < \pi \end{cases}$$

Determine h(n) based on frequency sampling technique. Take N = 7. **(10 Marks)**

b. Design a FIR filter (low pass) with desired frequency response :

$$H_d(e^{j\omega}) = \begin{cases} e^{-j3\omega}, & \frac{-3\pi}{4} \le \omega \le \frac{3\pi}{4} \\ 0, & \frac{3\pi}{4} < |\omega| < \pi \end{cases}$$

The Hamming window with N = 7. Also obtain frequency response. **(10 Marks)**

8 a. Design a digital filter H(z) that when used in A/D–H(z)–D/A structures gives an equivalent analog filter with the following specifications.

Passband ripple	: ≤ 3.01 dB
Passband edge	: ≤ 500 Hz
Stopband attenuation	: ≥ 15 dB
Stopband edge	: 750 Hz
Sample rate	: 2 KHz

Use bilinear transformation to design the filter on an analog system function, use Butterworth filter prototype. Also obtain difference equation. **(14 Marks)**

b. Compare IIR filter with FIR–filters. **(06 Marks)**

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10TE54

Fifth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Transmission Lines & Waveguides

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of Smith chart is permitted.***

PART – A

1 a. Derive expressions for voltage and current at any point on an uniform transmission line and hence deduce an expression for input impedance. **(12 Marks)**

b. A generator of 1.0 volt, 1000 cycles, supplies power to a 100-mile open wire line terminated in Z_O and having the following parameters ($\epsilon^{-J3.55}$ is equivalent to an angle of -3.55 radiens or -203.8 deg): R = 10.4 ohms per mile, L = 0.00367 henry per mile, G = 0.8×10^{-6} mho per mile, C = 0.00835 μF Per mile. Find α, β, γ, λ, Z_0, I_R, E_R and P_R (Received power). **(08 Marks)**

2 a. Design a constant – K high pass T and π-section filter to be terminated in 720 Ω having cut-off frequency of 6.8 kHz. **(08 Marks)**

b. Obtain the expression for input impedance in open and short circuited line. Plot the graph Z_{sc}/R_o versus distance and Z_{oc}/R_o versus **(12 Marks)**

3 a. Explain the applications of quarter waveline with a neat sketch. **(10 Marks)**

b. The characteristic impedance of the line is 50 Ω and SWR ρ = 2 when the line is loaded. When the line is shorted, the minima shifts 0.15λ towards load. Determine the load impedance. Use Smith chart. **(10 Marks)**

4 a. What are the applications and properties of Smith chart? Explain briefly with a neat sketch. **(10 Marks)**

b. A load impedance of $Z_R = 60 - j80\Omega$ is required to be matched to a 50 ohm co-axial line, by using a short circuited stub of length '*l*' located to a distance 'd' from the load. The wavelength of operation is 1 meter. Find 'd' and '*l*'. Show the co-axial line configuration of the stub with a neat sketch. **(10 Marks)**

PART – B

5 a. State and explain the properties of s-parameters. **(12 Marks)**

b. Two transmission lines of characteristic impedance z_1 and z_2 are joined at plane PP′. Express S-parameters in terms of impedances. **(08 Marks)**

6 a. Using the Helmholtz equation, derive the field equations for TM modes in rectangular waveguide. **(12 Marks)**

b. An air-filled circular waveguide having an inner radius of 1 cm is excited in dominant mode at 10 GHz (The dominant mode is TE_{11}, $X'_{11} = 1.841$. For TM_{01}, $x_{01} = 2.405$).
Find : (i) The cut-off frequency of dominant mode.
(ii) Guide wavelength.
(iii) Wave impedance
(iv) Find the bandwidth for operation in dominant mode only. **(08 Marks)**

7 a. With a neat sketch, explain the operation of Hybrid Tees and mention its applications. **(10 Marks)**

b. Explain directional coupler and obtain S-matrix of a two-hole directional coupler. **(10 Marks)**

8 a. Explain the working of a Schottky barrier diode with a neat sketch. **(07 Marks)**

b. Distinguish between Gunn, IMPATT and BARITT diodes. **(07 Marks)**

c. A sinusoidal input signal of frequency f_s and pump signal of frequency f_p are applied across a time varying non-linear capacitance. If the output circuit is a band-pass filter with resistive series load of frequencies $f_s + f_p$, calculate the power gain. **(06 Marks)**

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