Indian Institute of Space Science and Technology
AV314 - Communication Systems I
Department of Avionics

Quiz 1 for Semester V on 31/08/2018

Note to the student

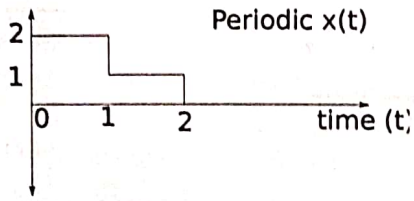
1. There are **5 questions** in this question paper on **2 pages**, for a total of **15 marks**.
2. Answer **all** questions.

Question 1 (3 marks):

1. Suppose $x(t)$ is periodic with period T seconds. Suppose the Fourier series exists for $x(t)$ and x_k, $k \in \mathbb{Z}$ are the Fourier series coefficients. What is its Fourier transform $X(f)$? (1 mark). (Hint: There is a way of representing periodic signals using δ functions.)
2. Suppose $\mathcal{H}(x(t))$ is the Hilbert transform of $x(t)$, then show that $\mathcal{H}(\mathcal{H}(x(t)))$ is $-x(t)$ (1 mark).
3. Suppose $x(t)$ is a real valued signal. Show that $x(t)$ and its Hilbert transform $\mathcal{H}(x(t))$ are orthogonal (1 mark).(Hint: two signals $x(t)$ and $y(t)$ are orthogonal if $\int_{-\infty}^{\infty} x(t)y(t)dt = 0$.)

Question 2 (6 marks):

1. Consider a periodic signal $x(t)$ which has a period of 2 seconds. The signal is defined over one period as shown below. Find out the Fourier series representation of $x(t)$. (2 marks)



2. Suppose $x(t)$ is the following aperiodic signal. Find out the Fourier transform of $x(t)$. (4 marks, full credit would be given for the answers that use standard functions such as step, δ, sin, cos, real-exponential, sinc etc.)

$$x(t) = \begin{cases} t, \text{ for } t \in [0,1], \\ 2-t, \text{ for } t \in [1,1.5], \\ 0, \text{ otherwise.} \end{cases}$$

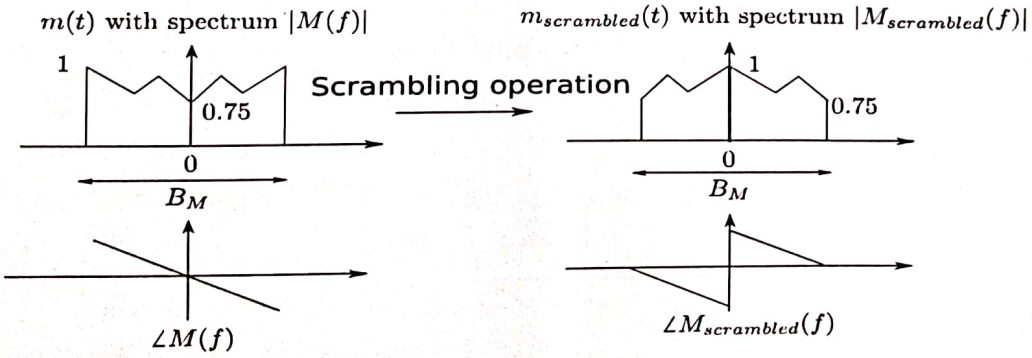
Question 3 (2 marks): Using a signal flow diagram/block diagram, explain how you would **transmit and receive** a baseband voice signal, with a two-sided bandwidth of 10kHz over a passband channel of two-sided bandwidth 10 kHz, centered at 1 GHz. What modulation and demodulation scheme would you use? Clearly indicate these in your block diagram. Also draw the Fourier magnitude spectrum of the signal that you obtain at the output of the modulator. (Hint: Would DSB or SSB be appropriate in this case?)

Question 4 (2 marks): Let $m(t) = 2cos(2\pi 500t) + 5cos(2\pi 1000t)$ be a baseband audio signal. This signal is transmitted over a baseband channel with spectrum $H(f)$ as follows

$$H(f) = \begin{cases} 1, \text{ for } |f| \in [0, 800], \\ 0.7, \text{ for } |f| \in (800, 1200], \\ 0.5, \text{ for } |f| \in (1200, 1500], \\ 0, \text{ otherwise.} \end{cases}$$

Describe what transmitter and receiver functions you would use (i.e. the $t(.)$ and $r(.)$ functions) so that you would be able to recover $m(t)$ at the destination. (All frequencies are in Hertz.)

Question 5 (2 marks): In many voice communication systems, in order to protect the speakers from eavesdropping, the voice signals are scrambled before communication. The scrambling operation can be described using the following transformation, as illustrated for a real valued voice signal $m(t)$.



Draw a signal flow diagram/block diagram representation of a system which would take $m(t)$ as input and produce $m_{scrambled}(t)$ as output. For each block in your block diagram clearly label what the block does (using either an input output formula in time domain, or the frequency response if LTI). Also draw the Fourier magnitude response for all the signals in your system.

Best of luck!

Indian Institute of Space Science and Technology
AV314 - Communication Systems I
Department of Avionics

Quiz 2 for Semester V on 12/10/2018

Note to the student

1. There are **5 questions** in this question paper on **2 pages**, for a total of **15 marks**.
2. Answer **all** questions.

Question 1 (3 marks): Explain the Weaver's method of SSB modulation. Use a block diagram to explain the various steps in this process. Show how both upper and lower side band modulation can be achieved using this process.

Question 2 (2 marks): Explain how DSBSC is demodulated using a squaring synchronizer. How does the squaring synchronizer work?

Question 3 (3 marks): Consider a radio receiver that needs to receive a FM channel that has a one-sided bandwidth of 1MHz at 1800.5 MHz. In order to hear this channel satisfactorily, any nearby channels need to be attenuated to at least 60 dB. We want to design a superheterodyne receiver with a intermediate frequency (IF) of 300 MHz. The intermediate frequency is generated ~~by~~ using a local oscillator that is tunable from 1900 to 2250 GHz, with any frequency divider circuits if needed (frequency division can be done only by an integer). Design a superheterodyne receiver (use a block diagram in order to present your design) to receive the channel at 1800.5 MHz. Specify the characteristics of the RF and IF filters and show how the IF signal required ~~for~~ after mixing is generated. For the superheterodyne receiver that you have designed, what is the image frequency corresponding to the channel above?

Question 4 (3 marks): Suppose $m(t)$ is a general real valued modulating baseband signal, with energy contained in the frequency range $[-B_m, B_m]$. Assume that $x(t)$ is obtained from $m(t)$ by single side band modulation, using upper side band, using a carrier $cos(2\pi f_c t)$ with carrier frequency f_c, where $f_c \gg B_m$. The signal $x(t)$ is transmitted over an ideal channel such that the received signal $y(t)$ is $x(t)$ itself. The signal $y(t)$ is applied to an ideal FM demodulator. You can assume that the output $f(t)$ of the FM demodulator is the instantaneous frequency of $y(t)$.

1. Write down an expression for $f(t)$ in terms of $m(t)$.
2. Now, if suppose $m(t)$ were a pure sinusoid then what would $f(t)$ be?

Question 5 (4 marks): Consider the following idealized model for a PLL. The function

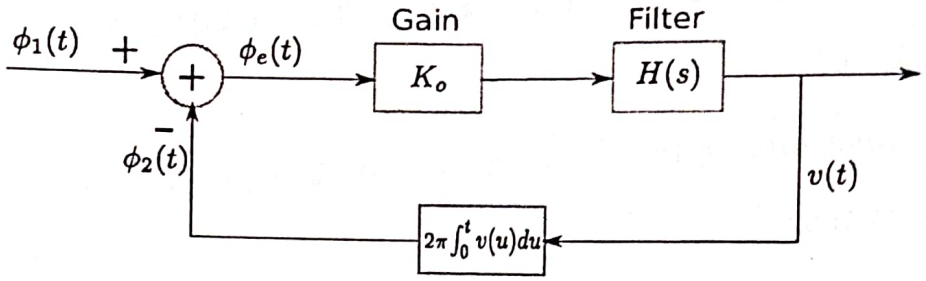


Figure 1: An idealized model for PLL

$\phi_1(t)$ is the phase for the input signal (assumed sinusoidal) and the function $\phi_2(t)$ is the phase for the signal put out by a VCO in the PLL. The difference between the two phases is the phase error signal $\phi_e(t) = \phi_1(t) - \phi_2(t)$. Suppose the system starts with the PLL in lock, so that the input $\phi_1(t)$ is 0 and therefore $\phi_2(t)$ is 0 for $t < 0$.

1. At $t = 0$ the input phase $\phi_1(t)$ changes; there is a frequency offset of Δf and a phase offset of $\Delta\theta$. For this idealized model, find out the steady state value of the phase error $\phi_e(t)$ if $H(s) = \frac{s+a}{s}$, where a is a positive real number and $H(s)$ is the transfer function of the filter.

2. Now suppose there is a frequency divider (division by an integer N) in the feed-back path from $v(t)$ to $\phi_2(t)$ as shown below. Find out the steady state value of the phase error $\phi_e(t)$ if $H(s) = \frac{s+a}{s}$, where a is a positive real number and $H(s)$ is the transfer function of the filter, when at $t = 0$ the input phase $\phi_1(t)$ changes; there is a frequency offset of Δf and a phase offset of $\Delta\theta$. What is the relationship between $\phi_3(t)$ and $\phi_1(t)$? What is one use of such a PLL structure?

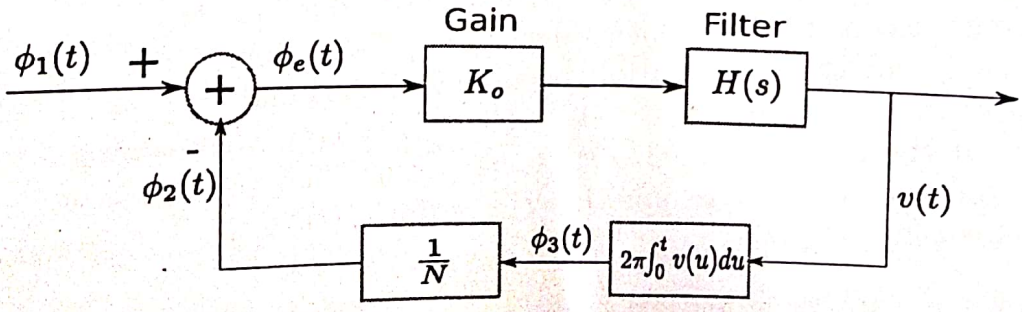


Figure 2: PLL with a frequency divider

Best of luck!

Indian Institute of Space Science and Technology
AV314 - Communication Systems I
Department of Avionics

Final Exam for 5th Semester, B.Tech (ECE) on 30/11/2018

Note to the student

1. There are **10 questions** in this question paper on **3 pages**, for a total of **50 marks.**
2. Answer all questions.

Question 1 (5 marks): Suppose $m(t)$ is a baseband voice signal of two-sided bandwidth B_M.

1. Using signal flow diagrams show how $m(t)$ is wideband frequency modulated using indirect frequency modulation methods.
2. Also show using signal flow diagrams how the wideband frequency modulated signal is demodulated to obtain an estimate of $m(t)$.

Question 2 (5 marks): In FM systems, as in question 1, frequency multiplication and division are essential tasks. Suppose we have a locally generated signal $l(t) = Acos(2\pi f_c t)$, explain how

1. a sinusoidal signal of twice the frequency, i.e., $2f_c$ can be generated from $l(t)$,
2. a sinusoidal signal of half the frequency, i.e., $f_c/2$ can be generated from $l(t)$.

Question 3 (8 marks): In question 1, after demodulating the FM signal and obtaining an estimate $\widehat{m}(t)$ of $m(t)$, the signal $\widehat{m}(t)$ is usually played out through a speaker via an audio amplifier. Due to unknown channel attenuation, the estimate $\widehat{m}(t)$ can be thought of as a scaled version of $m(t)$, i.e, $\gamma m(t)$ where $\gamma < 1$. We want to automatically control the peak amplitude of $\widehat{m}(t)$ to be 1V. Using a signal flow diagram, explain how an automatic gain control (AGC) system can be used to achieve this. You should explain the working of the AGC system using the signal flow diagram.

Question 4 (3 marks): Consider a FM receiver system which uses a limiter-discriminator for demodulation of a baseband signal $m(t)$. For such systems, explain why pre-emphasis filtering needs to be done on $m(t)$ before frequency modulation and de-emphasis filtering after demodulation. Please note that your explanation should include a discussion of the noise signal in the FM receiver.

Question 5 (3 marks): Consider a FM receiver system which uses a limiter-discriminator for demodulation of a baseband signal $m(t)$. For such systems, explain what the threshold effect is. Please note that your explanation should include a discussion of the noise signal in the FM receiver.

Question 6 (5 marks): Suppose $(X(t), t \in (-\infty, \infty))$ is a continuous time random process. Let the autocorrelation function of the random process be $R_{XX}(\tau) = e^{-a|\tau|}$, where τ is the time lead/lag variable. Find out the output power when $X(t)$ is passed through a bandpass filter with two sided bandwidth of $2W$. power has to be finite centre freq. of -

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Question 7 (6 marks): A deterministic signal $s(t)$ in a communication system has a spectrum $S(f)$ which is defined as

$$S(f) = \begin{cases} 1 - |f|, \text{ for } f \in [-1, 1], \\ 0, \text{ otherwise.} \end{cases}$$

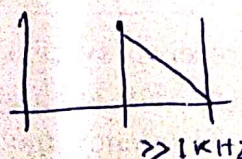
Teff = 1

The receiver in this system, receives a signal $y(t) = s(t) + N(t)$, where $N(t)$ is a random noise signal. The random noise signal $N(t)$ has a power spectral density 0.01 for all frequencies, i.e., it is white. The received signal $y(t)$ is passed through an ideal low pass filter with frequency response $H(f)$ defined as:

$$H(f) = \begin{cases} 1, \text{ for } f \in [-B, B], \\ 0, \text{ otherwise.} \end{cases}$$

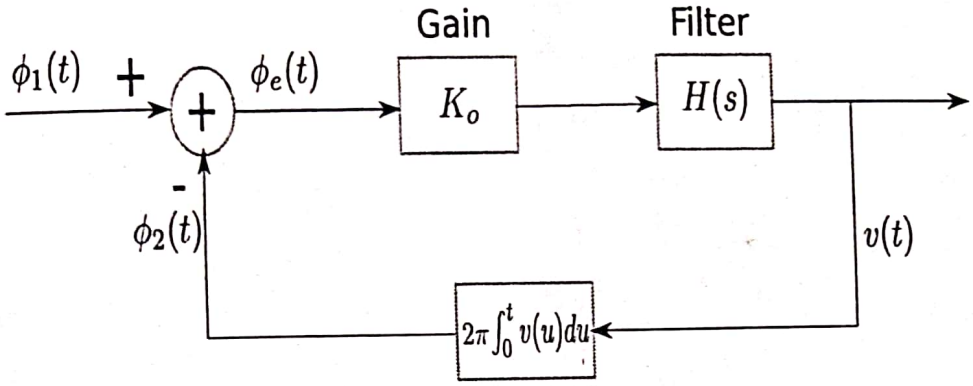
Derive the signal to noise ratio (SNR) at the filter output for the cases $B = 1$ and $B = 1/2$. For what B is the SNR better? Comment on whether the better SNR obtained at the cost of signal distortion.

Question 8 (5 marks): Suppose $m_1(t)$ and $m_2(t)$ are two baseband signals of two sided bandwidths 5kHz each. These two signals have to be transferred simultaneously from a source to a destination over a pass band channel of bandwidth 100 kHz, centered at 100 MHz. Assuming that one can only design filters (of any kind) with a transition band of width at least 1 kHz, explain using a signal flow diagram how this simultaneous transmission and reception can be done. Your explanation should include the spectrum of the signals at every point in your signal flow graph.



$e^{j2\pi f} \delta(f - f_0)$

Question 9 (5 marks): Consider the linearized model of the PLL shown below:



Suppose the above PLL is used for FM demodulation. The input to the PLL is an FM signal with instantaneous frequency deviation $\frac{10}{\pi}m(t)$, where $m(t) = 2cos(t) + sin(2t)$. Using the above linearized model of the PLL, find the time-domain expression for the estimated message provided by the PLL. (Hint: think about what happens to a sinusoid of frequency ω passing through a linear system with a specified transfer function.)

Question 10 (5 marks): Suppose $m(t)$ is a baseband signal of two sided bandwidth B_M. We are given a channel which takes a passband time domain signal $i(t)$ as input and produces a signal $o(t)$ as output. The passband signal $i(t)$ needs to be centered at f_c and can have a one-sided bandwidth of $100B_M$. But the channel is non-linear and the input output relationship is given as $o(t) = i(t)+0.75(i(t))^2+0.25(i(t))^3$. Suppose you are given the option to transmit $m(t)$ through the channel using amplitude modulation or frequency modulation. Justify mathematically, which one of the above schemes you would prefer. (Hint: think about the distortions that are produced by the non-linear channel on an amplitude modulated or frequency modulated $i(t)$.)

Best of luck!

Indian Institute of Space Science and Technology (IIST)

B. Tech, Avionics 3rd Year

Quiz I Question Paper

RF and Microwave Communication (AV 313), V Semester

Marks: 20 | Date of Exam: Sept 03'2018 | Time: 1 Hr

Note: Make suitable assumptions if necessary and clearly mention them.

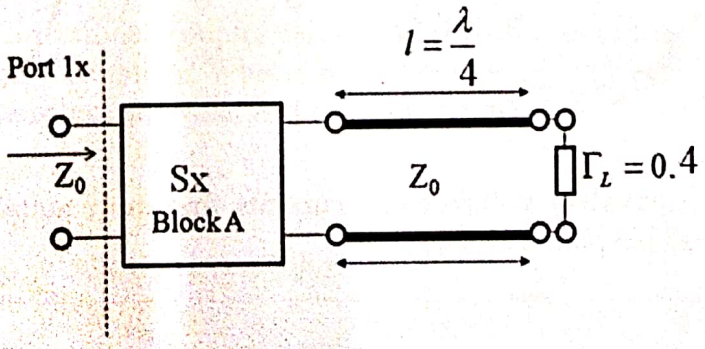
1. A four-port network has the scattering matrix shown as follows. [0.5+0.5]+[2] = [3]

$$[s]=\begin{bmatrix} 0.1\angle 90^0 & 0.8\angle -45^0 & 0.3\angle -45^0 & 0 \\ 0.8\angle -45^0 & 0 & 0 & 0.4\angle 45^0 \\ 0.3\angle -45^0 & 0 & 0 & 0.6\angle -45^0 \\ 0 & 0.4\angle 45^0 & 0.6\angle -45^0 & 0 \end{bmatrix}$$

(a) Is this network lossless?
(b) Is this network reciprocal?
(c) What is the reflection coefficient seen at port 1 if a short circuit is placed at the terminal plane of port 3 and all other ports are terminated with matched loads?

2. Below is a microwave device which is (input port at port1X) constructed using a microwave network block (A) and a Transmission line and a load. The s parameter of the Block A is given below. Find the Total Current through load Γ_L and the reflected voltage at port1x, using Signal Flow Graph (SFG) Technique. [Clearly mention the reduction rules]
[Take the Characteristic Impedance (Z_0) as 50 ohm. At the port1x the incident source voltage is 2j (Marked in arrow in Figure below). [2.5] + [2.5] = [5]

$$[S_x]=\begin{bmatrix} 0.35 & 0.5 \\ 0.5 & 0 \end{bmatrix}$$

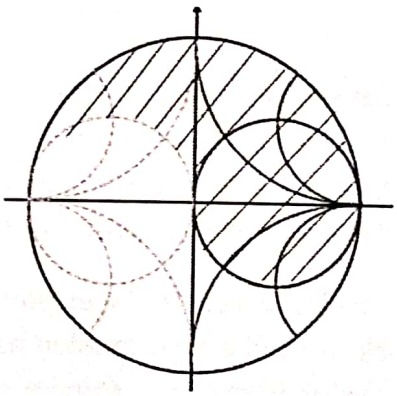


3. Show that if a microwave network is lossless then it will satisfy the criteria of a unitary matrix. [4]

4. Design a Lumped Matching network (with the help of the ZY Smith Chart) to transform the load impedance of 100+j100 to an input impedance of 50+j20 ohm. You can take the following assumptions: [3]

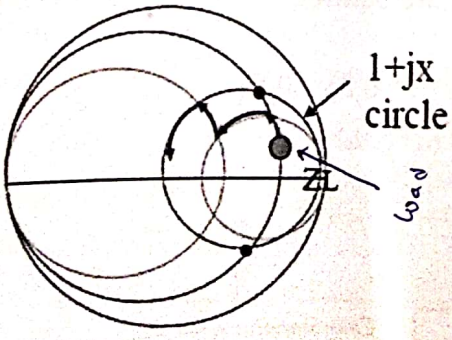
   (a) Design the matching circuit for narrow bandwidth requirement.
   (b) Don't have to assume the condition for maximum power transfer. You can directly take the load impedance at your starting point.
   (c) Take the characteristic impedance to be equal to 100 ohm.
   [Take the help of the given ZY Smith Chart]

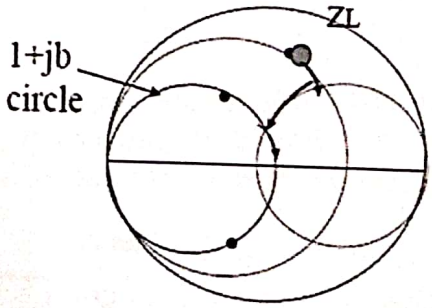
5. Draw the possible matching circuit configuration for the Load falling in the hatched region in the smith chart (shown below) for which matching to the 50 ohm (assume it in the origin of the smith chart) is not possible. (Forbidden) [1]



6. Draw the possible matching circuits for the following impedance loci traced in the smith charts. [Take origin as the source matching point]

[2]





7. Why the equivalent voltages and currents find more suitability in the case of Non-TEM lines? [Explain Briefly] [2]

END

Indian Institute of Space Science and Technology (IIST)

B. Tech, Avionics 3rd Year

Quiz II Question Paper

RF and Microwave Communication (AV 313), V Semester

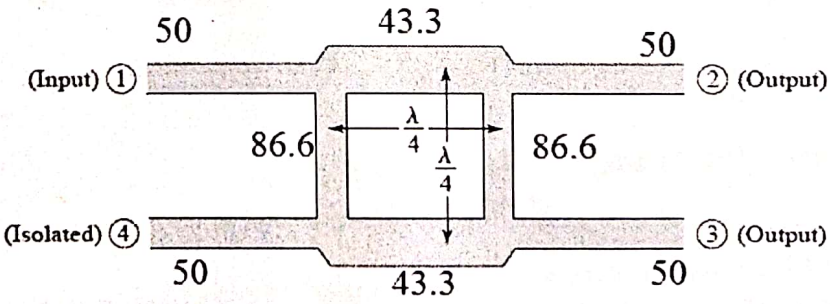
Marks: 15 | Date of Exam: October 15'2018 | Time: 1 Hr

Note: Make suitable assumptions if necessary and clearly mention them.

1. Design a two-Section Binomial Matching Transformer to match a 50 ohm Load to 75 ohm and calculate the percentage of Fractional Bandwidth for Minimum reflection Co-efficient value of 0.02. [Use the Approximate Expression] Draw the Signal Flow Graph of this Binomial Transformer. [3] + [1] = [4]

2. Using a single open shunt stub matching technique, design a matching circuit that will match the load impedance of 60+j80 ohm to a Transmission Line of 50 ohm. [Show any one solution and Draw the Matching circuit. Solve using the Z-Smith Chart and Mention Important Points in your answer sheet and correspondingly mark it in the Smith Chart, Assume that all the Transmission Lines used in the design are ideal] [3]

3. For a certain Branch Line Coupler as shown below, the input power is given 21 mW at input port 1. How much power (in dB) will be divided between the Port 2 and Port 3? Mention the Phase. Assume that all the ports are matched to 50 ohm. [Branch Impedances in ohm are mentioned along with the Branch] [5]



4. A coupled line directional coupler with characteristic impedance of 50 Ω is to be designed for 20 dB coupling. What would be its even and odd Mode Impedance? Which impedance is less and what is the reason for that? [1]+[1]+[1]= [3]

END

Indian Institute of Space Science and Technology (IIST)

B. Tech, Avionics 3rd Year

End-Sem Question Paper

RF and Microwave Communication (AV 313), V Semester

Marks: 50 | Date of Exam: December 03'2018 | Time: 3 Hr

Note: Make suitable assumptions if necessary and mention them clearly. Smith chart problem should be done in pencil in case you want to erase it you can. In the smith chart problem write your name and roll no also mention the question number.

If it is not mentioned, the symbols and variables usually have their usual meaning. It is a closed book exam, No Formula Sheet is allowed. Answer should be brief and to the point.

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1. (a) Consider two two-port networks with individual scattering matrices $[S^A]$ and $[S^B]$. Show that the overall S_{21} parameter of the cascade of these networks is given by [3]

$$S_{21} = \frac{S_{21}^A S_{21}^B}{1 - S_{22}^A S_{11}^B}.$$

(b) A four-port network has the scattering matrix shown as follows. [5]

$$[s] = \begin{bmatrix} 0.1\angle 90^0 & 0.8\angle -45^0 & 0.3\angle -45^0 & 0 \\ 0.8\angle -45^0 & 0 & 0 & 0.4\angle 45^0 \\ 0.3\angle -45^0 & 0 & 0 & 0.6\angle -45^0 \\ 0 & 0.4\angle 45^0 & 0.6\angle -45^0 & 0 \end{bmatrix}$$

(a) Is this network lossless?
(b) Is this network reciprocal?
(c) What is the reflection coefficient seen at port 1 if a open circuit is placed at the terminal plane of port 3 and all other ports are terminated with matched loads?

2. (a) Using single open shunt stub matching technique, design a matching circuit that will match the load impedance of 60-j80 ohm to a Transmission Line of 50 ohm. Assume the Frequency of the Operation is 2 GHz. [Show any one solution, solve in the Smith Chart and Mention Important Points in your answer sheet and correspondingly mark it in the Smith Chart, Assume that all the Transmission Lines are ideal] [4]

(b) If the above impedance matching (in Question 2 (a)) is to be done using Quarter Wave Transformer, Demonstrate a scheme and design the circuit to achieve that operation. Use the Same Smith Chart to obtain the important values using ideal Transmission Lines. Considering a design frequency of 10 GHz , implement and draw the schematic Lay-out of this matching Network in a microstrip Line environment in a Low-loss Alumina substrate having relative permittivity ε_r =9.9 and d=0.5mm (thickness of the substrate). [You may use the Following Relations]

[2] + [2] = [4]

$$\varepsilon_e = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(1 + \frac{12d}{W}\right)^{-\frac{1}{2}}$$

$$A = \frac{Z_0}{60}\sqrt{\frac{\varepsilon_r + 1}{2}} + \frac{\varepsilon_r + 1}{\varepsilon_r + 2}\left(0.23 + \frac{0.11}{\varepsilon_r}\right)$$

$$B = \frac{377\pi}{2Z_0\sqrt{\varepsilon_r}}$$

$$\frac{W}{d} = \begin{cases} \dfrac{8e^A}{e^{2A} - 2} & \text{for } W/d < 2 \\ \dfrac{2}{\pi}\left[B - 1 - \ln(2B-1) + \dfrac{\varepsilon_r - 1}{2\varepsilon_r}\left\{\ln(B-1) + 0.39 - \dfrac{0.61}{\varepsilon_r}\right\}\right] & W/d > 2 \end{cases}$$

3. (a) Design a single-Section Quarter Wave Matching Transformer to match a 100 ohm Load to 50 ohm at f_0 = 3 GHz and calculate the percentage of Fractional Bandwidth for which the Standing Wave Ratio (SWR)≤1.5. Draw the Signal Flow Graph of this Quarter Wave Transformer. [3] + [1] = [4]

$$\frac{\Delta f}{f_0} = 2 - \frac{4}{\pi}\cos^{-1}\left[\frac{\Gamma_m}{\sqrt{1-\Gamma_m^2}}\frac{2\sqrt{Z_0 Z_L}}{|Z_L - Z_0|}\right]$$

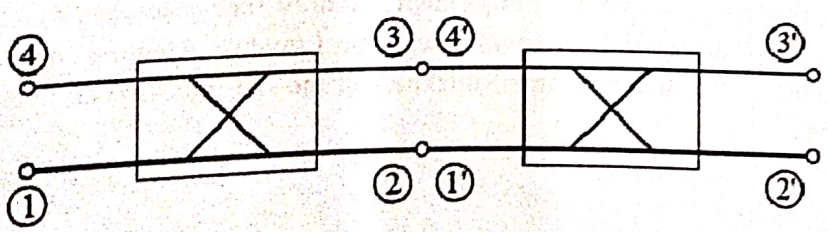
(b) A load of $Z_L / Z_0 = 0.5$ is to be matched to a feed line using a binomial multi-section transformer, and it is desired to have a passband response with $|\Gamma(\theta)| = A(0.1 + \cos^2\theta)$ for $0 \le \theta \le \pi$. Use the approximate theory for multi-section transformers to design a two-section transformer. [3]

(c) An ultra wide band (UWB) Radio Transmitter, operating from 3.1 to 10.6 GHz drives a parallel RC Load with R = 75 Ohm and C=0.6 pF. What is the best return Loss that can be obtained with an optimum matching network? [2]

4. (a) A directional coupler has the scattering matrix given below. Find the return loss, coupling factor, directivity, and insertion loss. Assume that the ports are terminated in matched loads. [4]

$$[S] = \begin{bmatrix} 0.05\angle 30 & 0.96\angle 0 & 0.1\angle 90 & 0.05\angle 90 \\ 0.96\angle 0 & 0.05\angle 30 & 0.05\angle 90 & 0.1\angle 90 \\ 0.1\angle 90 & 0.05\angle 90 & 0.04\angle 30 & 0.96\angle 0 \\ 0.05\angle 90 & 0.1\angle 90 & 0.96\angle 0 & 0.05\angle 30 \end{bmatrix}$$

(b) Two identical 90° couplers with C = 8.34 dB are connected as shown below. Find the resulting phase and amplitudes at ports 2' and 3', relative to port 1. [3]



(c) Obtain the scattering parameters of an ideal lossless 3 dB Branch Line coupler or Quadrature 90^0 hybrid physically or intuitively. [No need to derive the odd mode and even mode Equations] If 15 mW signal is applied at any one of its input port what will be power exiting from other three ports? [3]

(d) A lossless T junction Power divider has a source impedance of 50 ohm. Find the output characteristic impedances so that the input power is divided into 3:1 ratio. Compute the reflection co-efficients seen looking into the output ports. [2]

5. (a) Design a low pass third order maximally flat filter using only series stubs. The cut-off frequency is 6 GHz and the impedance is 50 ohm. [3]
Assume the values [$g_1 = 1, g_2 = 2, g_3 = 1$]
(b) Design a low pass fourth order maximally flat filter using only shunt stubs. The cut-off frequency is 8 GHz and the impedance is 50 ohm. [3]
Assume the values [$g_1 = 0.7654, g_2 = 1.8748, g_3 = 1.8748, g_4 = 0.7654$]
(c) Design a stepped-impedance low-pass filter with cut-off frequency of 2.0 GHz and R_0 = 50 ohm , Thin microstrip line is having characteristic impedance 15 ohm and thin line is characteristic impedance of 15 ohm. [5]
(i) Find the electrical Length of the five sections.
(ii) Lay out the microstrip implementation of the filter on an FR4 substrate having ε_r = 4.2, d = 0.158 cm, and tan δ = 0.01, and with copper conductors 0.787 mm thick.
[You May Use the following Relations]

$$\varepsilon_e = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(1 + \frac{12d}{W}\right)^{-\frac{1}{2}}$$

$$A = \frac{Z_0}{60}\sqrt{\frac{\varepsilon_r + 1}{2}} + \frac{\varepsilon_r + 1}{\varepsilon_r + 2}\left(0.23 + \frac{0.11}{\varepsilon_r}\right)$$

$$B = \frac{377\pi}{2Z_0\sqrt{\varepsilon_r}}$$

$$\frac{W}{d} = \begin{cases} \dfrac{8e^A}{e^{2A} - 2} & \text{for } W/d < 2 \\ \dfrac{2}{\pi}\left[B - 1 - \ln(2B-1) + \dfrac{\varepsilon_r - 1}{2\varepsilon_r}\left\{\ln(B-1) + 0.39 - \dfrac{0.61}{\varepsilon_r}\right\}\right] & W/d > 2 \end{cases}$$

(d) How a shorted Transmission Line can act as a microwave resonator? Comment on the Quality Factor of this kind of resonator. [2]

Indian Institute of Space Science and Technology

Department of Avionics

AV 312: Computer Architecture and Organization, July-December 2018

Quiz-I

Name: Subham Saha **Student Number:** SC16B053

Date: 29/08/2018 **Max Score: 30**

1. Draw the block diagram of a 5 stage pipeline for the instruction-level parallelism of a computer

[3 Marks]

2. The cache block size in many computers is in the range of 32 to 128 bytes. What would be the two main advantages and disadvantages of making the size of cache blocks larger or smaller?

[2 Marks]

3. A block-set-associative cache consists of a total of 64 blocks, divided into 4-block sets. The main memory contains 4096 blocks, each consisting of 32 words. Assuming a 32-bit byte-addressable address space, how many bits are there in each of the Tag, Set, and Word fields?

[4 Marks]

4. Explain any three Replacement algorithms for cache memory.

[3 Marks]

5. Explain Interleaved memory with advantages

[3 Marks]

6. Devise a 7-bit even parity Hamming code for the digit 9

[5 marks]

7. Consider a long sequence of accesses to a disk with an average seek time of 6 ms and an average rotational delay of 3 ms. The average size of a block being accessed is 8K bytes. The data transfer rate from the disk is 34Mbytes/sec.

   (*a*) Assuming that the data blocks are randomly located on the disk, estimate the average percentage of the total time occupied by seek operations and rotational delays.

   (*b*) Repeat part (*a*) for the situation in which disk accesses are arranged so that in 90 percent of the cases, the next access will be to a data block on the same cylinder.

[10 Marks]

All the best

PS: For the problems, procedure to be explained, showing workouts

Indian Institute of Space Science and Technology

Department of Avionics

AV 312: Computer Architecture and Organization, July-December 2018

Quiz-2

Name: **Student Number:**

Date: 10/10/2018 **Max Score: 30**

1. Draw the block diagram of a sample architecture of a PCIe system with three PCIe ports. [3 Marks]

2. Compare PCI with PCIe in terms of bits, clock rate and throughput [2 marks]

3. Explain the major difference between traps and interrupts [2 Marks]

4. A microcomputer has words of 2 bytes. What is the smallest and largest integer that can be represented in the following:
   a) Unsigned representation
   b) Twos complement signed representation
   [4 Marks]

5. Convert the following expression from infix to reverse polish
   (A / B) – (((C – D * E) / F) / G) / H
   [4 marks]

6. Convert the following into infix notation and evaluate it step by step showing the arithmetic and stack instructions, as done by a computer using stack.
   (3 + 20 / 5) * (6 + 3 * 4) / 9
   [8 Marks]

7. Compare internal fragmentation to external fragmentation. How can we reduce this? [3 Marks]

8. Explain a process and a program [2 marks]

9. Write two differences of demand paged virtual memory and caching [2 Marks]

All the best

PS: For the problems, procedure to be explained, showing workouts

Indian Institute of Space Science and Technology

Department of Avionics

AV 312: Computer Architecture and Organization, July-December 2018

End Semester Examination

Name: **Student Number:**

Date: 26/11/2018 **Max Score: 100**

1. Consider a 32-bit microprocessor that has an on-chip 16-KByte four-way set-associative cache. Assume that the cache has a line size of four 32-bit words. Where in the cache is the word from memory location ABCDE8F8 mapped?

[5 Marks]

2. Assume a processor having a memory cycle time of 300 ns (nano sec) and an instruction processing rate of 1 MIPS (Million instructions per second). On average, each instruction requires one bus memory cycle for instruction fetch and one for the operand it involves.

   (i) Calculate the utilization of the bus by the processor.
   (ii) Suppose the processor is equipped with an instruction cache and the associated hit ratio is 0.5. Determine the impact on bus utilization.

[5 Marks]

3. Consider a 4-drive, 200GB-per-drive RAID array. What is the available data storage capacity for each of the RAID levels, 0, 1, 3, 4, and 5?

[5 Marks]

4. Consider a disk that rotates at 3600 rpm. The seek time to move the head between adjacent tracks is 2 ms (milli sec). There are 64 sectors per track, which are stored in linear order from sector 0 through sector 63. The head sees the sectors in ascending order. Assume the read/write head is positioned at the start of sector 1 on track 8. There is a main memory buffer large enough to hold an entire track. Data is transferred between disk locations by reading from the source track into the main memory buffer and then writing the data from the buffer to the target track. Computing the exact rotational latency, answer the following.

   a) How long will it take to transfer sector 1 on track 8 to sector 1 on track 9?
   b) How long will it take to transfer all the sectors of track 8 to the corresponding sectors of track 9?

[10 Marks]

5. Consider a system in which bus cycle takes 500 ns (nano sec). Transfer of bus control in either direction, from processor to I/O device or vice versa, takes 250 ns. One of the I/O devices has a data transfer rate of 75 KB/s(Kilo Bytes/sec) and employs DMA. Data are transferred one byte at a time. Suppose we employ DMA in a burst mode. That is, the DMA interface gains bus mastership prior to the start of a block transfer and maintains control of the bus until the whole block is transferred. For how long would the device tie up the bus when transferring a block of 256 bytes?

[5 Marks]

6. A computer has a cache, main memory, and a disk used for virtual memory. If a referenced word is in the cache, 15 ns (nano sec) are required to access it. If it is in main memory but not in the cache, 50 ns are needed to load it into the cache, and then the reference is started again. If the word is not in main memory, 10 ms (milli sec) are required to fetch the word from disk, followed by 50 ns to copy it to the cache, and then the reference is started again. The cache hit ratio is 0.9 and the main-memory hit ratio is 0.6. What is the average time in ns required to access a referenced word on this system?

[10 Marks]

7. Assume a stack-oriented processor that includes the stack operations PUSH and POP. Arithmetic operations automatically involve the top one or two stack elements. Begin with an empty stack. What stack elements remain after the following instructions are executed? Show stack contents after the execution of every instruction.

```
PUSH 4
PUSH 7
PUSH 8
ADD
PUSH 10
SUB
MUL
```

[5 Marks]

8. Consider the following loop:

```
S := 0;
for K := 1 to 100 do
S := S - K;
```

A straight forward translation of this into a generic assembly language would look like this:

```
        LD   R1, 0          ;keep value of S in R1
        LD   R2, 1          ;keep value of K in R2
LP      SUB  R1, R1, R2     ;S :=S - K
        BEQ  R2,100, EXIT   ;done if K = 100
        ADD  R2, R2, 1      ;else increment K
        JMP  LP             ;back to start of loop
```

A compiler for a RISC machine will introduce delay slots into this code so that the processor can employ the delayed branch mechanism. NOP instruction will also be inserted, if needed. Write one such resulting code and explain.

[5 Marks]

9. Draw a finite state diagram for branch prediction in such a way that it should change prediction only after three consecutive wrong predictions.

[5 Marks]

10. Explain the following
    a) Difference between a subroutine and an interrupt-service routine?
    b) Multi-programming
    c) Super-pipelining

[5 Marks]

11. A RISC processor of 1-GHz (Giga Hz) clock that uses the following five-step sequence

Step 1 : Fetch an instruction and increment the program counter.
Step 2 : Decode the instruction and read registers from the register file.
Step 3 : Perform an ALU operation.
Step 4 : Read or write memory data if the instruction involves a memory operand.
Step 5 : Write the result into the destination register, if needed.

Instruction statistics in a large program are as follows:

Branch	-	20%
Load	-	20%
Store	-	10%
Computational instructions	-	50%

Estimate the rate of instruction execution in each of the following cases:

a) Access to the memory is always completed in 1 clock cycle.
b) 90% of instruction fetch operations are completed in one clock cycle and 10% are completed in 4 clock cycles. On average, access to the data operands of a Load or Store instruction is completed in 3 clock cycles.

[10 Marks]

12. Using the normal nomenclature of k-way set associative mapping, define your own terms/alphabets for: 1) number of lines in the cache, 2) number of sets, 3) number of lines in each set, 4) Tag, 5) Set, and 6) Word. Using the terms/alphabets, write answers for the following with units (where ever possible answer in terms of power 2)

    1. Address Length
    2. Number of addressable units

3. Block size
4. Line size
5. Number of Blocks in main memory
6. Number of lines in a set
7. Number of sets
8. Number of lines in cache
9. Size of cache
10. Size of tag

[10 Marks]

13. Consider a cache of 4 lines of 16 bytes each. Main memory is divided into blocks of 16 bytes each. That is, block 0 has bytes with addresses 0 through 15, and so on. Now consider a program that accesses memory in the following sequence of addresses:

Once: 63 through 70
Loop ten times: 15 through 32; 80 through 95

Suppose the cache is organized as two-way set associative, with two sets of two lines each. Even-numbered blocks are assigned to set 0 and odd-numbered blocks are assigned to set 1. Compute the hit ratio for the two-way set-associative cache using the least recently used replacement scheme.

[10 Marks]

14. Answer the following:

a) How many check bits are needed if the Hamming error correction code is used to detect single bit errors in a 2048-bit data word?

[3 Marks]

b) A process references five pages, A, B, C, D, and E, in the following order:

A; B; C; D; A; B; E; A; B; C; D; E

Assume that the replacement algorithm is first-in-first-out. Find the number of page transfers during this sequence of references starting with an empty main memory with three page frames.

[5 Marks]

c) Describe one advantage and one disadvantage of program-counter-relative addressing

[2 Marks]

****

All the best

PS: Answer should contain all the required steps, work outs and explanation

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM, 695 547
B.Tech Quiz 1 – November 2018
AVD611 – Digital Signal Processing
Time: One hour Date: 30/08/2018 Max. Marks: 30

1. Show that the set of functions $\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{pi}}\cos(x), \frac{1}{\sqrt{pi}}\sin(x), \frac{1}{\sqrt{pi}}\cos(2x), \frac{1}{\sqrt{2}}\sin(2x), \ldots$ is orthonormal. Also specify the interval over which the orthogonality holds. [10]

2. Find the set of polynomials which are orthonormal in the space of continuous real valued functions on the interval $\{x| -1 \leq x \leq 1\}$. Start with $\phi_1(x) = c$, $\phi_2(x) = ax^2 + b$, $\phi_3(x) = \alpha x^2 = \beta x + \gamma$ etc... Find the expression for $\phi_n(x)$. [10]

3. Since $z = e^{sT_s}$, where T_s is the sampling interval, consider the $s-$plane. Map the $x-$ and $y-$ axes of the $s-$plane to obtain the $z-$plane. Point out the differences. [10]

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM, 695 547
B.Tech Quiz 2 – October 2018
AVD611 – Digital Signal Processing
Time: One hour Date: 11/10/2018 Max. Marks: 30

1. Given that the 3 taps of the impulse response is $h(0) = 1$, $h(1) = 1.3$ and $h(2) = 0.4$
   (a) Write the $z-$transfer function, call it $H_1(z)$. Find the roots of the polynomial. [1]
   (b) Write the other 3 spectrally equivalent polynomials. Call them $H_2(z), H_3(z)$ and $H_4(z)$ [6]
   (c) Plots the poles and zeros for all the polynomials. [3]
   (d) Evaluate the magnitude function $C_1(z)$, $C_2(z)$, $C_3(z)$ and $C_4(z)$ and compare them. [4]
   (e) Plot the poles and zeros of $C_1(z)$, $C_2(z)$, $C_3(z)$ and $C_4(z)$. [4]
   (f) Which amongst them is a minimum/maximum phase system. [2]
   (g) For the rest of the systems, perform the minimum phase and all-pass factorization. Clearly state the minimum phase part and the all-pass part. Also obtain the minimum-phase inverse of the system. [6]
   (h) For the all-pass systems obtained above, draw the pole-zero plots. [4]
   (i) What is the relation between the minimum phase and the maximum phase polynomials. [2]
2. Given that $h(n) = \alpha^n u(n)$, write all the possible inverse systems. Plots the ROCs. [8]

AV311 -Digital Signal Processsing
End Semester Examination
Indian Institute of Space Science and Technology, Thiruvananthapuram - 695547

November 27, 2018

1. Whats the difference between the phase and group delays.
   - How are they defined mathematically ? For what kind of signals are they defined ? [4]
   - What is the relation between phase and phase delay ? Explain with the aid of an example. [2]
   - Why are the phase and group delays so defined ? [5]
   - When are they both identically the same. [2]
   - How are they important, say for filter design or otherwise, while designing an LTI system [3]
   - For what kind of systems is the magnitude response sufficient to describe the entire system (including the phase response). How is the magnitude and phase of such a system related ? [3]

2. ~~Which of the following~~ ~~systems~~ ~~find the amplitude~~ Obtain magnitude, phase response (plot phase response alone). Write your inference [10]
   - $H_1(z) = -1 + 2z^{-1} - 3z^{-2} + 6z^{-3} - 3z^{-4} + 2z^{-5} - z^{-6}$
   - $H_2(z) = 1 - 2z^{-1} + 3z^{-2} - 6z^{-3} + 3z^{-4} - 2z^{-5} + z^{-6}$

3. Which of the transfer functions correspond to lowpass and highpass filters. Plot the poles and zero. Comment on their stability. [6]
   - $H(z) = \frac{1}{2}(1 + z^{-1})$
   - $H(z) = \frac{1}{2}(1 - z^{-1})$

4. Given two system $H_1(z) = \frac{z+b}{z+a}, 0 < |a| < 1$ and $H_2(z) = \frac{bz+1}{z+a}, 0 < |b| < 1$,
   - prove that they both have the same magnitude functions.[6]

- which amongst is a minimum phase system and why.[3]
- Factorize the non-minimum phase system in terms of the minimum-phase component and the all-pass system. [4]

5. Given the signal $X(n) = A\sin(\omega_0 n)$ $-\infty < n\infty$, plot the (i) DTFT (magnitude and phase in the same plot) and (ii) DTFS of the signal. [10] 6. Given the signal $X(n) = A\sin(\omega_0 n)$ $-0 < nN$, where $N = \frac{2\pi}{\omega_0}$ plot the (i) DTFT (magnitude and phase in the same plot) and (ii) N-point DFT of the signal. [10] 7. Given the signal $X(n) = A\sin(\omega_0 n)$ $-0 < nN'$, where $N' = N + m$ where m is an arbitrary integer, plot the (i) DTFT (magnitude and phase in the same plot) and (ii) N'-point DFT of the signal. Explain the plots. [10] 8. The DTFT is computed over dense grid of frequencies ω_k, where $X(e^{j\omega_k}) = \sum_{n=0^N} x(n)e^{\omega_k n}$. There are M number of ω_k terms. If the M-pt IDFT of it is taken, how will the signal look like , when [15]

- $M > N$
- $M < N$
- $M = N$

Plot the resulting time domain signals assuming $x(n) = \cos(2\pi n/N)$. Choose $N = 64$ and $M = 80, 48$ and 64 respectively.

$\frac{2\pi}{\omega_0}$

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM 695 547

Quiz I - August 2018

B. Tech - V Semester

MA311 - Probability, Statistics and Numerical Methods

Date: 27/08/2018 **Time: 9.00 am - 10.00 am** **Max. Marks: 15**

Attempt all questions

1. (a) State Baye's Theorem.

   (b) A company has 4 machines A,B,C,D manufacturing bulbs. The machines A,B,C,D produce 50%, 25%, 15% and 10% bulbs respectively. The percentage of defective bulbs produced by the machine A,B,C,D are 2%, 1%, 1%, 0.5% respectively. Out of the output, one bulb is choosen at random. What is the probability that is defective? [1+3 marks]

2. The density function (pdf) of coded measurements of the pitch diameter of threads of a fitting is

$$f(x) = \begin{cases} \dfrac{k}{1+x^2}, & 0 < x < 1, \\ 0, & \text{elsewhere.} \end{cases}$$

   Find (a) the constant k (b) mean (c) variance. [4 marks]

3. Define the distribution function of a random variable. What are its essential properties? Does the function F given by

$$F(x) = \begin{cases} 0, & \text{if} \quad x < 0, \\ x, & \text{if} \quad 0 \le x < \frac{1}{2}, \\ 1, & \text{if} \quad x \ge \frac{1}{2} \end{cases}$$

   define a distribution function? [3 marks]

4. Let X be a random variable having pdf $f(x) = \dfrac{1}{2\lambda} e^{-|x-\mu|/\lambda}$, $-\infty < x < \infty$; $\lambda > 0$, $-\infty < \mu < \infty$. Show that the mgf exits and find it. Hence find the mean and the variance of X. [4 marks]

END

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM 695 547

Quiz II - October 2018

B. Tech - V Semester

MA311 - Probability, Statistics and Numerical Methods

Date: 08/10/2018 **Time: 9.00 am - 10.00 am** **Max. Marks: 15**

Attempt all questions

1. A soft-drink machine has a random amount Y_2 in supply at the beginning of a given day and dispenses a random amount Y_1 during the day (with measurement in gallons). It is not resupplied during the day, and hence $Y_1 \leq Y_2$. It has been observed that Y_1 and Y_2 have a joint density given by

$$f(y_1, y_2) = \begin{cases} \frac{1}{2}, & 0 \leq y_1 \leq y_2 \leq 2, \\ 0, & \text{otherwise.} \end{cases}$$

   Find the conditional density of Y_1 given Y_2. Evaluate the probability that less than 1/2 gallon will be sold, given that the machine contains 1.5 gallons at the start of the day. [4 marks]

2. Let X be an exponential variate having parameter λ. Find the distribution function $F(\cdot)$ of X. Also, find the probability distribution of $F(X)$. [3 marks]

3. (a) State Chebyshev inequality, stating all condition. Write atleast two advantages of the inequality. [2 marks]

   (b) State Central Limit Theorem, stating all conditions. [2 marks]

   (c) Let $X_1, X_2, \cdots, X_{81}$ be iid random variables with mean 54 and variance 225, Use Chebyshev's inequality to find the possible difference between the sample mean and the population mean with a probability of atleast 0.75. [2 marks]

   (d) Use Central limit Theorem to do the same given in (c). Compare the results with the one obtained in (c) and comment on the results. [2 marks]

END

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM 695 547

End Semester Examination - November 2018

B.Tech - V Semester

MA311 - Probability, Statistics and Numerical Methods

Date: 19/11/2018 **Time: 1.30 pm - 4.30 pm** *Max. Marks: 100*

SECTION A (Attempt all 10 questions - 10x5= 50 marks.)

1. Give the axiomatic definition to probability. Let Ω be the set of all non-negative integers, and U the class of all subsets of Ω. In each of the following cases, does P define a probability function on (Ω, U)? For $A \in U$,

   (i) $P(A) = \sum_{x \in A} \frac{e^{-\lambda}\lambda^x}{x!}, \lambda > 0$ and

   (ii) $P(A) = \sum_{x \in A} p(1-p)^x, 0 < p < 1.$

2. The duration T of a certain type of telephone calls is found to satisfy the relation

$$P(T > t) = ae^{-\lambda t} + (1-a)e^{-\mu t}, t \geq 0,$$

   where $0 \leq a \leq 1, \lambda > 0, \mu > 0$ are constants. Find the mean and variance of T.

3. A coin having probability p of coming up heads is successively flipped until the r^{th} head appears. If X is the number of flips required, find the probability distribution of X. Also, find the probability that there are exactly six flips required to get third head, when a fair coin is used.

4. If X and Y are independent Poisson variates having parameters λ_1 and λ_2 respectively, find the conditional probability distribution of X given that $X+Y = n$. Also, compute $E(X/X+Y=n)$.

5. Let $X_1, X_2, \cdots X_n$ be a random sample of size n taken from a normal population having mean μ and variance σ^2. Using mgf, show that $\sum_{i=1}^{n} \frac{(X_i - \mu)^2}{\sigma^2}$ follows χ^2 distribution with n degrees of freedom.

6. (a) What are the desirable properties of a good estimator? Define each property.

   (b) Let $X_1, X_2, \cdots, X_n$ be a random sample from a normal population $N(\mu, \sigma^2)$ and $T = \sum_{i=1}^{n} \frac{(X_i - \bar{X})^2}{n}$, is suggested as an estimator for the variance σ^2. Is T a biased estimator for σ^2? Is T a consistent estimator? Justify your answer.

7. Consider a random sample of $X_1, X_2, \cdots, X_n$ of observations from a Weibull distribution with parameters α and β and density function

$$f(x) = \begin{cases} \alpha\beta x^{\beta-1}e^{-\alpha x^\beta}, & x > 0 \\ 0, & \text{elsewhere,} \end{cases}$$

   for $\alpha, \beta > 0$.

(i) Find the maximum likelihood estimators of α and β.

(ii) Compute the MLE estimates of α and β, if the sample 2, 2.1, 2.2, 2.5, 3.2 is given.

8. Define "one tailored" and "two tailored" tests. Let a sample of size n with sample variance s^2 is taken from a normal population with variance ${\sigma_0}^2$. Propose a rejection (critical region) with level of significance, α to test the claim that population variance is greater than ${\sigma_0}^2$.

9. Explain Newton-Raphson method for finding root of an equation $f(x) = 0$ and show that it has convergence of order 2.

10. Describe the Lagrange interpolation procedure to fit a polynomial of degree 3 to a set of four data points. Also, find an upper bound for the error of approximation.

SECTION B (Attempt any 5 questions - 5x10= 50 marks.)

11. (a) State and prove Bayes' rule.

(b) In answering a question on a multiple choice test, a candidate either knows or does not know the answer with respective probabilities p and $1 - p(0 \leq p \leq 1)$. If he knows the answer, he puts down the correct answer with probability 0.99, whereas if he guesses, the probability of his putting down the correct result is $1/k$ (k choices to answer). Find the conditional probability that the candidate knew the answer to a question, given that he has made the correct answer. Show that this probability tends to 1 as $k \to \infty$.

12. (a) State Chebyshev's inequality. For the random variable with pdf

$$f(x) = \frac{e^{-x}x^{\lambda}}{\lambda!}, x > 0,$$

where $\lambda \geq 0$ is an integer, show that

$$P\{0 < X < 2(\lambda + 1)\} > \frac{\lambda}{\lambda + 1}.$$

(b) Let (X, Y) have the joint pdf defined by $f(x, y) = 1/2$ inside the square with corners at the points (1,0), (0,1), (-1,0), and (0,-1) in the XY plane, and $= 0$ otherwise. Find the marginal densities of X and Y and the two conditional densities.

13. (a) Let a random varaible X follows χ^2 - distribution with 35 degrees of freedom. Find $P(X \leq 45)$ using Central Limit Theorem.

(b) Find a $100(1 - \alpha)\%$ prediction/confidence interval of a future observation x_0 for a normal distribution of measurements with unknown mean μ when (i) variance σ^2 is known (ii) variance σ^2 is unknown.

14. (a) A random sample of 100 automobile owners in the state of Virginia shows that an automobile is driven on average 23,500 kilometers per year with a standard deviation of 3900 kilometers. Assume the distribution of measurements to be approximately normal.

(i) Construct a 99% confidence interval for the average number of kilometers an automobile is driven annually in Virginia.

(ii) What can we assert with 99% confidence about the possible size of our error if we estimate the average number of kilometers driven by car owners in Virginia to be 23,500 kilometers per year?

(b) A random sample of 20 students yielded a mean of $\bar{x} = 72$ and a variance of $s^2 = 16$ for scores on a college placement test in mathematics. Assuming the scores to be normally distributed, construct a 98% confidence interval for σ^2.

15. (a) A manufacturer has developed a new fishing line, which the company claims has a mean breaking strength of 15 kilograms with a standard deviation of 0.5 kilogram. To test the hypothesis that $\mu = 15$kilograms against the alternative that $\mu < 15$ kilograms, a random sample of 50 lines will be tested. The critical region is defined to be $\bar{x} < 14.9$.

(i) Find the probability of committing a type I error when H_0 is true.

(ii) Evaluate the power of the test, β for the alternatives $\mu = 14.8$ and $\mu = 14.9$ kilograms.

(b) A study was conducted to see if increasing the substrate concentration has an appreciable effect on the velocity of a chemical reaction. With a substrate concentration of 1.5 moles per liter, the reaction was run 15 times, with an average velocity of 7.5 micromoles per 30 minutes and a standard deviation of 1.5. With a substrate concentration of 2.0 moles per litre,12 runs were made, yielding an average velocity of 8.8 micromoles per 30 minutes and a sample standard deviation of 1.2. Is there any reason to believe that this increase in substrate concentration causes an increase in the mean velocity of the reaction of more than 0.5 micromole per 30 minutes? Use a 0.01 level of significance and assume the populations to be approximately normally distributed with equal variances.

16. (a) Explain the Gauss-Jacobi iteration scheme to solve the system $AX = b$.

(b) Set up the above scheme to solve the system of equations

$$\begin{bmatrix} 3 & -6 & 2 \\ -4 & 1 & -1 \\ 1 & -3 & 7 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 23 \\ -15 \\ 16 \end{bmatrix}.$$

Show that the scheme is divergent.

(c) Exchange the first and second equations and set up the Jacobi scheme to solve the above system. Show that the scheme is convergent. Also, find three iterates of this scheme by taking $X^{(0)} = 0$.

END

Indian Institute of Space Science and Technology
Thiruvananthapuram

B. Tech.
Fifth Semester -2016 Admissions
CH 311 – Environmental Science and Engineering

Quiz I
9.00 AM, August 28, 2018

Time: 1-hour **Maximum marks: 30**

Each question carries 5 marks

1. Write a note on phosphorous cycle (with the help of a scheme). What is eutrophication? Explain.
2. Define sustainable development. How is creation of buffer zone and watershed management practices are being useful in sustainable development.
3. Write a note on Soil formation **-or-** Classification of soils in India
4. Discuss (a) White revolution in India and (b) Biodiversity in Western Ghats
5. What are the causes of 'Global warming'? Explain.
6. *'Equitable distribution of resources is a step towards sustainable development'* Suggest a protocol (practice) that can be used in our IIST campus (suggest something unique and feasible, to get full credit).

Indian Institute of Space Science and Technology
Thiruvananthapuram
B. Tech.
Fifth Semester -2016 Admissions
CH 311 – Environmental Science and Engineering

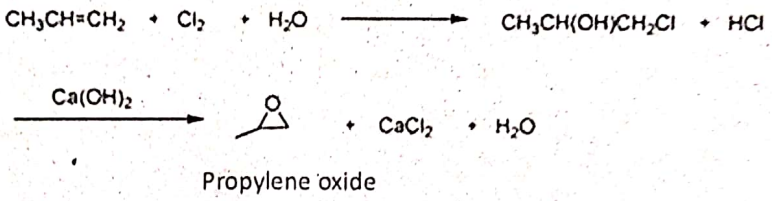
Quiz II

9.00 AM, October 09, 2018

Time: 1-hour **Maximum marks: 30**

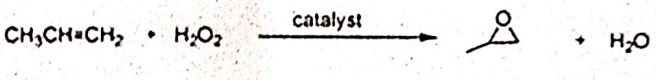
1. Define green chemistry. (2)
2. Use of enzyme help us to follow green chemistry, How? Explain with an example. (3)
3. Two chemical processes that lead to propylene oxide is shown below. If an industry wants to follow green chemistry principle, which reaction is desirable? Why? Explain. (*atom economy should be calculated for the full credit*) (5)

1. Chlorohydrin process



Propylene oxide

2. Catalytic oxidation with H_2O_2



Propylene oxide

Atomic weight of C = 12, H= 1, O=16, Ca = 40, Cl =35

4. Discuss any three different types of reverse osmosis (RO) membrane (eg: tubular). (3)
5. The performance characteristic of RO systems is normally defined by various parameters. Explain (i) permeate flux, (ii) salt rejection and (ii) recovery rate. (6)
6. What is the specific advantage of double pass RO system over single pass RO system? (2)
7. Another term of E-waste is WEEE. Expand the acronym WEEE. (1)
8. What are the different categories (classifications) of E-waste? (4)
9. Write a note of e-waste disposal methods. (4)

Indian Institute of Space Science and Technology
Thiruvananthapuram
B. Tech.
Fifth Semester -2016 Admissions
CH 311 – Environmental Science and Engineering

End Semester Examinations

1.30- 4.30 pm, November 21, 2018

Time: 3-hour **Maximum marks: 100**

Answer any 10 questions

1. (a) What are the factors affecting aquatic life? (3)

   (b) Describe oxygen cycle. Write at least three pathways leads to oxygen gain and oxygen loss. (5)

   (c) Give the primary classification of natural resources with examples. (2)

2. Describe steps towards sustainable developments. Give examples wherever possible. (10)

3. (a) Write a note on mineral resources in India and the environmental effects of mining. (6)

   (b) Write the classifications of soils in India (4)

4. (a) What are the component structures of a river valley project? (5)

   (b) What are the objectives of Kyoto protocol? (5)

5. (a) What is a greenhouse gas? Give two examples. (3)

   (b) Explain the **causes** and **effects** of global warming. (7)

6. 'Environmentally Sound E-Waste Treatment Technologies' involve three tier (three level) treatment system. Explain. (use scheme, examples wherever possible) (10)

7. 'Green chemistry' protocol is based on some principles. Explain the **first five** principles of 'green chemistry' with proper examples. (10)

8. (a) What is the use of 'multimedia filter' (MMF) in a RO system? Explain its function. (5)

   (b) Draw the schematic showing single stage RO, two stage RO and double pass RO system. (Show the *feed water*, *permeate water* and *concentrate* in the scheme). (5)

9. (a) Describe the detection of air pollutants by absorptions of infrared radiation. (5)

   (b) Write a note on 'Wet scrubbers' used for air pollution control (including its advantages and disadvantages). (5)

10. (a) What are the causes of soil pollution? Explain (5)

    (b) Describe the phytoremediation method of soil pollution removal. (5)

11. (a) Write a note on important water quality parameters (eg: turbidity) and its effects. (5)

    (b) Explain the primary, secondary and tertiary steps involved in sewage water treatment. (5)