INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY

AV 322 : POWER ELECTRONICS

QUIZ – I

Time: 60 minutes | *Answer all questions.* | Maximum marks: 30 | Date: 14 Feb 2023

Note : Use linear approximation for all waveforms. Derive the formulae used (except basic formulae).

1. In the buck converter shown in Fig.1, Vs=15V, L=0.16 mH, C=20 μF, R=12 Ω. The inductor has a parasitic resistance of 0.02 Ω. The ON state voltage drops of the switches S1 and S2 are 0.8V and 0.6V respectively. The switching frequency is 25KHz and the duty ratio (D) of the switch S1 is 0.8.
   a. Draw the circuit diagram with non-idealities and evaluate the output voltage (Vo).
   b. Determine the operating duty ratio at which this converter will enter into discontinuous conduction mode (DCM).
   c. Determine the inductance of the inductor (L) required if this converter has to operate in continuous conduction mode (CCM) for all values of the duty ratio (D).

   (10 Marks)

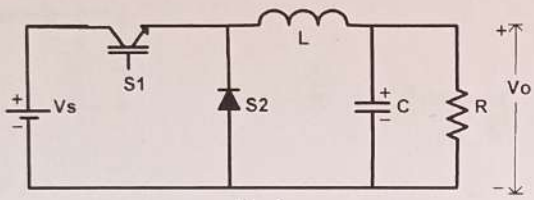


Fig.1

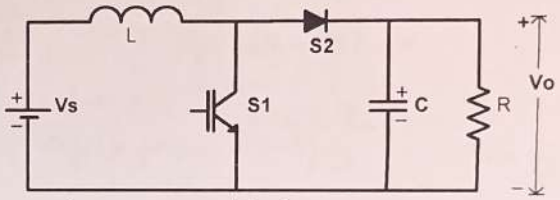


Fig. 2

2. In the boost converter shown in Fig.2, Vs=30V, R=50 Ω, L= 40 μH. The switching frequency is 50 KHz and the duty ratio of the switch S1 is 0.5. All components are ideal.
   a. Determine the mode of operation of the converter (CCM or DCM).
   b. Evaluate the output voltage of the converter.
   c. Sketch the waveform of the voltage across the diode and mark all salient points.

   (10 Marks)

3. The source voltage Vs in the buck-boost converter shown in Fig.-3 varies from 30V to 50V. The load R varies from 20 Ω to 100 Ω. The output voltage has to be maintained at 20V always. The switching frequency is 50 KHz. All components are ideal.
   a. Determine the range of variation of the duty ratio.
   b. Evaluate the inductance 'L' such that the converter operates in CCM always.
   c. Evaluate the capacitance 'C' such that the ripple in the output voltage is always less than 0.2V.

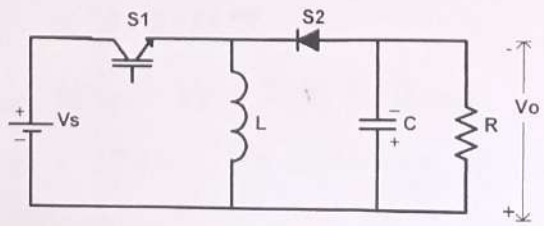


Fig.3

(10 Marks)

kamal

AV 322 : POWER ELECTRONICS

TEST – II

Time: 60 minutes | *Answer all questions.* | *Maximum marks:30* | *Date: 07 Mar, 2023*

Note : Use linear approximation for all waveforms.

1. The two switch forward converter shown in Fig.1 is operating with the following parameters: Input voltage (Vs)=100V, Load resistance R=2 Ω, L=24 μH. Duty ratio D=0.4. Switching frequency is 50KHz. Primary magnetizing inductance is 4mH. The switches S1, S2, D1 and D2 have a voltage drop of 1V in the ON-state. The diodes D3 and D4 may be considered ideal. Turns-ratio Np:Ns= 1 : 0.25. Evaluate the output voltage and efficiency of power conversion.

(10marks)

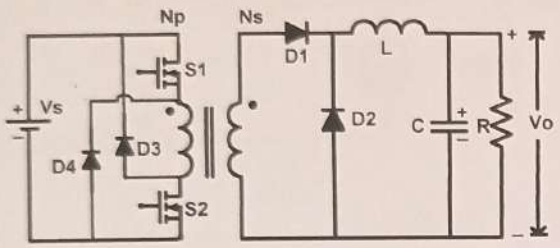


Fig.1

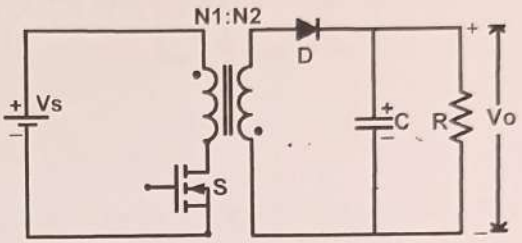


Fig.2

2. A flyback converter operating in DCM is shown in Fig.2. It delivers a voltage of 15V to the load of R=10 Ω Vs=48V. The secondary winding conducts for one half of the OFF time of the active switch (S). The switching frequency is 20KHz. Turns ratio N1:N2= 1:0.5.
   (a) Evaluate primary inductance and secondary inductance.
   (b) Sketch the waveforms of primary current and secondary current and mark all salient points.

(10 marks)

3. The Cuk converter shown in Fig.3 operates in CCM with the following parameters:
   Switching frequency Fs = 100 KHz, Duty ratio D=0.4, Vs=120V, R=10 Ω, L1=54μH, L2=270μH.
   (a) Sketch the waveforms of currents through the MOSFET and diode and mark all salient points.
   (b) If the diode has a forward voltage drop of 0.8 V and MOSFET has an ON-state voltage drop of 0.9V, evaluate the conduction losses in diode and MOSFET. Ignore the effect of switch non-idealities on output voltage while calculating the losses.

(10 marks)

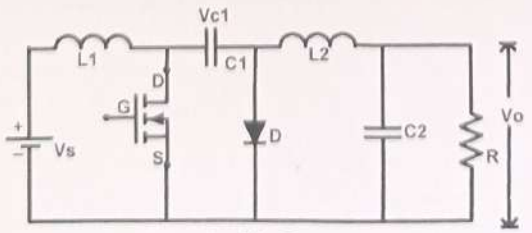


Fig.3

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY

AV 322 : POWER ELECTRONICS
QUIZ – 2

Time: 60 minutes | *Answer all questions.* | Maximum marks: 30 | Date: 28 March 2023

Note : Use linear approximation for all waveforms. Derive the formulae used (except basic formulae).

1. The two switch forward converter shown in Fig.1 is operating with the following parameters: Input voltage (Vs)=100V, Load resistance R=2 Ω, L=24 μH. Duty ratio D=0.4. Switching frequency is 50KHz. Primary magnetizing inductance is 4mH. The switches S1, S2, D1, D2, D3 and D4 have a voltage drop of 1V in the ON-state. Turns-ratio Np:Ns= 1 : 0.25.
   (a) Evaluate the output voltage
   (b) Evaluate the total conduction loss in D3 and D4

(10 Marks)

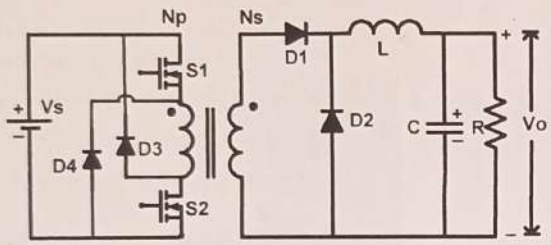


Fig.1

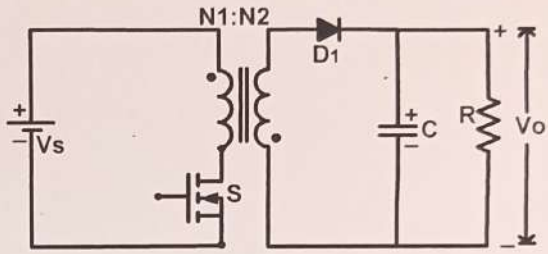


Fig. 2

2. The flyback converter shown in Fig.2 is delivering a power to a load of resistance R=1 Ω . The turns ratio N1:N2 is 1 : 0.125. Vs=100 V. The secondary inductance is 5 μH. The capacitance C= 100 μF. Duty ratio D=0.6. The switching frequency is 10 KHz. All components are considered to be ideal.
   (a) Verify that the converter is operating in discontinuous flux mode.
   (b) Evaluate the power delivered to the load.

(10 Marks)

3. A pulse width modulated H-bridge inverter feeding an R-L load of R=10 Ω, L=30 mH is shown in Fig.-3. The inverter output voltage is a quasi-square wave with a centred pulse having a width of 5mS. The frequency of the fundamental component of output voltage is 50Hz.
   (a) Evaluate the peak value of the fundamental component of the output voltage.
   (b) Evaluate the active power consumed by the load at the fundamental frequency.

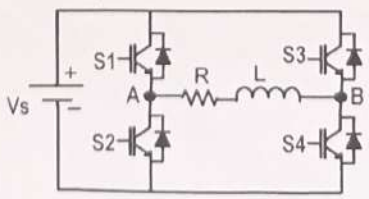


Fig.3

(10 Marks)

AV322 – Power Electronics: Test-2 April 2023

1. Fig. 1 shows a pulse width modulated H-bridge inverter and its output voltage waveform. The waveform has half- wave symmetry and quarter-wave symmetry.
   (a) Prove that the output voltage will not have 3rd harmonic for all possible values of 'θ'.
   (b) Determine the value of 'θ' if 5th harmonic has to be eliminated from output voltage.
   (c) Evaluate the total harmonic distortion of the output voltage under the condition given in 1(b).

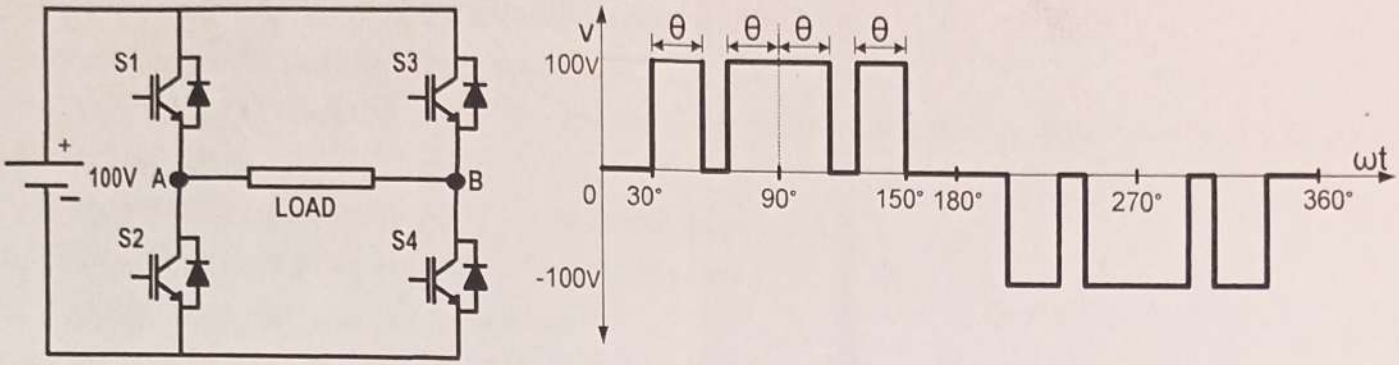


Fig.1

2. A two quadrant drive is shown in Fig.2 . The armature resistance of the motor is 0.6 Ω. Vs=300V. Initially the motor is running at 1200 RPM in the forward motoring mode, drawing a current of 60A. The converter operates at a duty ratio of 0.8 in this mode. Regenerative braking is now employed to bring down the speed to 600 RPM in the forward direction at a constant armature current of 30 A. The field current is kept constant under all conditions. All components are considered to be ideal.
   (a) Determine the range of duty ratio variation during the regenerative braking.
   (b) Evaluate the total power returned to the source due to regenerative braking.

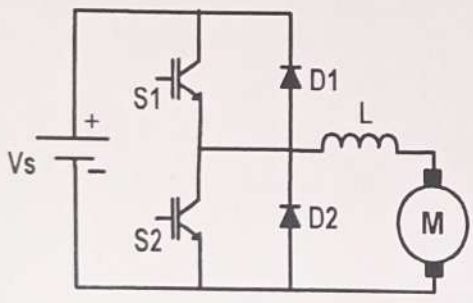


Fig.2

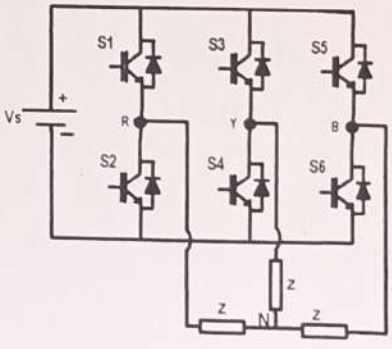


Fig.3

3. A three-phase inverter operated in square wave mode at 50 Hz and supplying a balanced star connected R-L load is shown in Fig.3. Input DC voltage (Vs) = 300V.
   Evaluate the total harmonic distortion (THD) of the phase voltage (V_{RN}).

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY

SIXTH SEMESTER B.TECH ECE - END SEMESTER EXAMINATION – MAY 2023

AV322 – POWER ELECTRONICS

Time : 3 hours | **Answer all questions** | **Maximum marks : 140**

Note: Derive the formulae used (except basic formulae). Use linear approximation for all waveforms.

1. The buck converter shown in Fig.1 has non-ideal components as given below.
   The inductor has a parasitic resistance of 0.02 Ω.
   The active switch (S1) has an ON state voltage drop of 0.8V.
   The diode has an ON state voltage drop of 0.6V.
   Vs=15V, L=0.16 mH, C=20 μF, R=12 Ω. The converter is operating with a duty ratio of 0.8 at a switching frequency of 25KHz.
   (a) Evaluate the DC current drawn from the input source (Vs).
   (b) Evaluate the peak to peak ripple in the inductor current.
   (c) Evaluate the power loss in the inductor. *(20 Marks)*

2. An ideal boost converter is shown in Fig.2. Vs=30V, R=15 Ω, C=90 μF duty ratio D=0.5, and switching frequency Fs=50 KHz.
   (a) Determine the inductance (L) if the peak value of the current in the inductor is 16 A.
   (b) Evaluate the ripple in the output voltage (Vo).
   (c) Evaluate the average value of the current in the active switch (S1). *(20 Marks)*

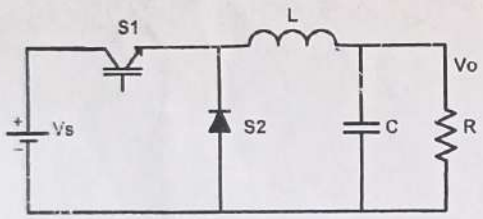


Fig.-1

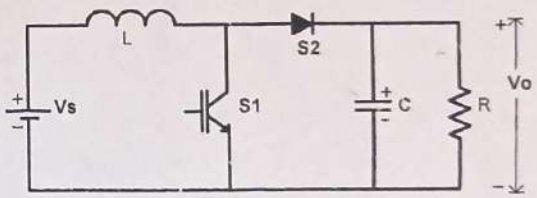


Fig.-2

3. The buck-boost converter with ideal components shown in Fig.-3 is operating in discontinuous conduction mode (DCM). Vs=30V, R=50 Ω, L=50 μH. The switching frequency is 50 KHz and the duty ratio of the switch S1 is 0.5.
   (a) Evaluate the conduction period of the diode (S2).
   (b) Evaluate the output voltage (Vo).
   (c) Evaluate the capacitance (C) required if the ripple in the output voltage shall not exceed 0.5V.
   (20 Marks)

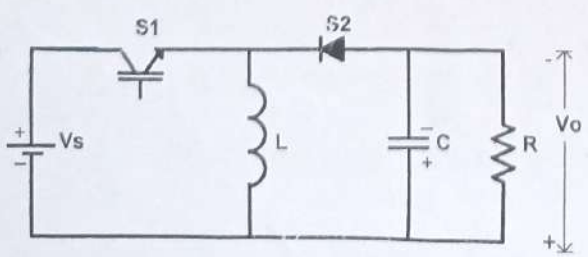


Fig.-3

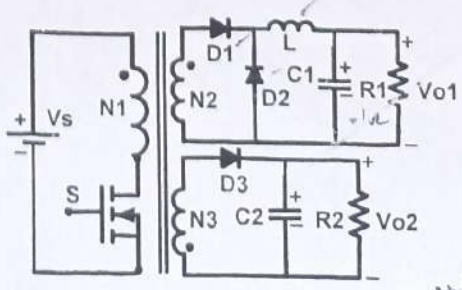


Fig.-4

4. A non-ideal switched mode power converter with two outputs shown in Fig.4. A voltage drop of 0.8V exists across the diodes D1 and D2 and the MOSFET (S) when they are in the ON-state. The inductor 'L' has a parasitic resistance of 15 mΩ. The magnetising inductance referred to primary winding is 500 µH. Input voltage (Vs)=24V, Load resistance R1=1Ω, R2 is not given. Duty ratio of the switch (S) D=0.4. Switching frequency is 50KHz. Turns-ratio N1:N2= 3 : 2, N1:N3= 1 : 1. Evaluate the following.
   (a) Power delivered to the load R1.
   (b) Power delivered to the load R2.
   (c) Overall efficiency of the converter considering the power delivered to both loads. *(20 Marks)*

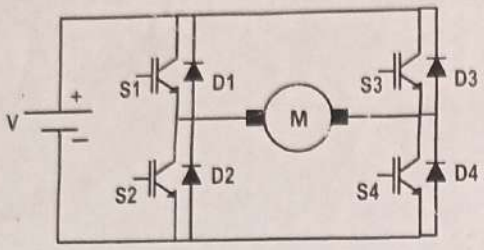


Fig.-5

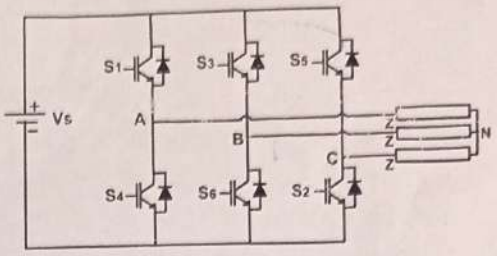


Fig.-6

5. A four quadrant separately excited DC motor drive used in an electric vehicle is shown in Fig-5. It is powered from a 200V battery. The field current of the motor is kept constant. The armature resistance of the motor is 0.5 Ω. The vehicle was being driven on a level road at a constant motor speed of 800 RPM while the converter was operating at a duty ratio of 0.8 and the armature drawing a current of 60A. The vehicle then moves down a gradient in the same direction but the speed is maintained at 800 RPM by employing regenerative braking while the motor current is kept constant at 20A. The switching frequency is 20 KHz. Assume that all components are ideal and ripple in the armature current is negligible. Neglect the transient effects while switching. Evaluate the following.
   (a) Average currents flowing through (i) switch S1, (ii) switch S4 and (iii) diode D2 and the mechanical power developed in the motor when the vehicle is moving on the level road.
   (b) Average currents flowing through (i) switch S2, (ii) diode D4 and (iii) diode D1 and the power absorbed by the battery when the vehicle is moving down the gradient. *(20 Marks)*

6. A three-phase inverter operated in square wave mode at 50 Hz and supplying a balanced star connected R-L load is shown in Fig.6. The load (Z) consists of R=10 Ω, L=10 mH. Input DC voltage (Vs) = 300V.
   (a) Sketch the waveform of the line voltage V_{AB}. Prove that it does not contain 3rd harmonics.
   (b) Evaluate the total harmonic distortion (THD) of the load current considering the fundamental component, 5th harmonic component and 7th harmonic component of the phase voltage. *(20 Marks)*

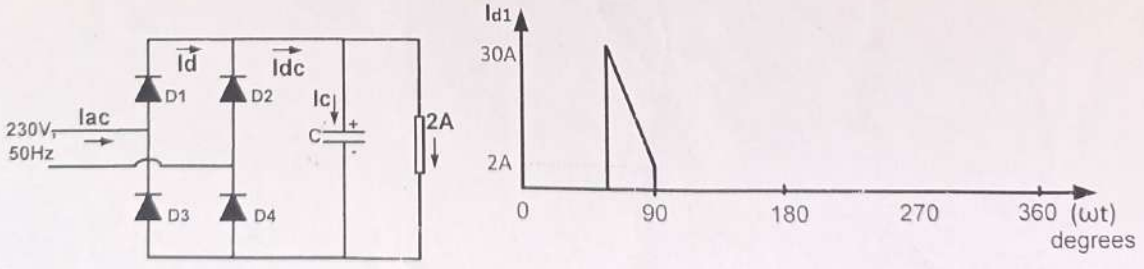


Fig.-7

4. Fig.7 shows a diode bridge rectifier with a capacitor filter and the waveform of the current through the diode D1 for a cycle of the input voltage. The rectifier is fed by a single phase, 50 Hz, 230 V (RMS) AC supply. The load connected at the output of the rectifier is drawing a constant current of 2A.
   (a) Sketch the waveform of the capacitor current (Ic) and mark all salient points.
   (b) Determine the peak to peak ripple in the output voltage of the rectifier.
   (c) Determine the value of capacitance 'C' required for this operation. *(20 Marks)*

Indian Institute of Space Science and Technology
Department of Avionics

Quiz-I | AV 321: Computer Networks, January-May 2023

Name: | Student Number:

Date: 13/02/2023 | Max Score: 15

Assume suitable data necessary, if any. However, clearly state the assumptions made.

1. (3 points) **Consider a 10Mbps link that is used by many users in a network. Each user is typically active only at 20% of the time and when a user is active, the data rate generated is 1Mbps. Estimate the following: *(a)* the number of users that can be supported if the network is circuit switched and *(b)* the probability of the network facing the situation of 4 times the number of users estimated in the above case *(a)* being active at any given time. Can the network support the users obtained in the case *(b)*? Explain what happens if all the users of case *(b)* are active. Assume a suitable large number of node population, if necessary.**

2. (3 points) **In a packet switched network, derive an expression for estimating the end-to-end delay experienced between two hosts separated by *K* network devices where each packet faces a queuing delay *Dq*. The propagation delay of each link is *Dp*. Also estimate the time delay experienced in generating a 120byte packet Vs a 60 byte from the analog signals produced by a human voice source.**

3. (3 points) **In a layered protocol stack similar to the Internet Protocol stack with 5 layers, an encapsulation mechanism is utilized. The Application, Transport, and Network layers have a header of 20 bytes each. The Data link and physical layers have a Header as well as Trailer of 20 bytes each. What will be the size of the transmitted physical layer data when the application layer payload is 120 bytes. Also estimate the percentage overhead due to the encapsulation.**

4. (3 points) **Draw an explain the Internet Protocol stack. Compare and contrast with ISO-OSI protocol stack.**

5. (3 points) **Describe the design and novelty aspects of your Track-3 project.**

Best of luck

Indian Institute of Space Science and Technology
Department of Avionics

Quiz-II AV 321: Computer Networks, January-May 2023

Name: Kamal Maurya Student Number:

Date: 27/03/2023 Max Score: 15

Assume suitable data necessary, if any. However, clearly state the assumptions made.

1. (3 points) In a computer network, a router uses an M/M/1/K queuing model to handle incoming packets. The arrival rate of packets (λ) follows a Poisson distribution with an average of 6 packets per second, and the service rate (μ) follows an exponential distribution with an average of 10 packets per second. The router's buffer can hold a maximum of 5 packets, including the packet being served (K = 5). The router drops incoming packets if the buffer is full.

   a) Determine the average number of packets in the system (L).
   b) Calculate the average time a packet spends in the system (T).
   c) Find the packet loss probability (P_loss).

2. (3 points) What are the different dimensions of a bit? In an RF wireless communication network, a symbol is created using 4 information bits. The devices in the network uses 1400-byte packets. Transmitter/receiver antennas use unitary gain. If the data rate of the physical layer channel is 54 Megabits per second, estimate the following:
   a. The physical length of the symbol?
   b. Physical length of the packet?
   c. The temporal duration of the symbol?

3. (3 points) Explain in detail the operation of content distribution networks with examples. What are the major advantages or services offered by content distribution networks.

4. (3 points) In a computer network ~~where~~ a client is downloading a large file from a server using the Transmission Control Protocol (TCP). The client and server are connected through a network with the following parameters:

   Link capacity: C = 100 Mbps

   Propagation delay: d_prop = 50 ms (one-way)
   Processing delay: d_proc = 5 ms (one-way, at each router)
   Queueing delay: d_queue = 5 ms (one-way, at each router)

   There are 2 intermediate routers between the client and server.

   Given this information, answer the following questions:

   a) Calculate the round-trip time (RTT) for the network.
   b) Compute the Bandwidth-Delay Product (BDP) for the network.
   c) Determine the minimum number of packets to be sent by the sender to achieve maximum bandwidth utilization.

5. (3 points) Provide (i) detailed technical design of your innovative R&D product development activity with the timeline for completion and (ii) major feedbacks received during your Q1 review.

Best of luck

Indian Institute of Space Science and Technology (IIST)
Department of Avionics [www.iist.ac.in]

6th Semester B.Tech ECE Semester Finals
AV 321: Computer Networks, Jan-May 2023

Name: Kamal
Student ID: SC20B15
Date: 17/05/2023 **Duration: 3 hours** **Max Score: 50**

Make suitable assumptions, if necessary, and clearly state them. Answers should be marked with question/branch question numbers properly. Clear and legible steps are necessary for answers.

1. **(10 points)**
   a. Explain the details of binary exponential backoff mechanism of CSMA/CD.
   b. Consider an Ethernet network where the CSMA/CD protocol is used. The network uses a data rate of 100 Mbps and has a total length of 1 kilometer. The network has 25 nodes. The signal propagation speed over the network cable is approximately 2 x 10^8 meters/second.
      i. Suppose a network node, Node A, starts transmitting a frame just as another node, Node B, at the other end of the network (1 km away) finishes transmitting its own frame. Calculate the time it will take for Node A to detect a collision in case of one.
      ii. What is the minimum size of the frame that Node A needs to transmit to ensure that if a collision occurs, it can detect it during transmission?
      iii. With the minimum size calculated in (ii) above, estimate the maximum throughput achievable in the network.

2. **(10 points)** Consider a satellite communication network where users transmit data packets to a satellite using a Slotted ALOHA protocol with a slot duration of 25ms. The satellite acts as a relay, forwarding the received packets to a base station on Earth. The base station has a single-server queuing system that handles the incoming packets. The queuing system follows an M/M/1/K model, with a finite buffer size (K) that can hold up to 20 packets. The service rate (μ) at the base station is 50 packets per second. Users generate packets according to a Poisson process with a mean rate (λ) of 40 packets per second.
   a. What is the probability that a packet is successfully transmitted to the satellite using the Slotted ALOHA protocol?
   b. Calculate the traffic intensity (ρ) for the queuing system at the base station.
   c. What is the probability (Pk) that all 20 buffers in the base station are full?
   d. Given the above system parameters, what is the average time a packet spends in the system and the queue?
   e. If the satellite network is to be designed to ensure the average delay for a packet is not more than 10 milli seconds, what changes would you recommend to the system parameters, if any?

3. **(10 points)**
   a. Compare and contrast the link state and distance vector routing approaches.
   b. Explain the operation of Dijkstra's shortest path routing algorithm?
   c. What is the purpose of Netmask? How is it used?
   d. What are the responsibilities of data link layer?
   e. In what situations, packet switching is better than circuit switching? Explain with examples.

4. **(10 points)** Consider an Industrial IoT system where a camera attached to a conveyor belt station uses TCP for its transport layer. The camera is configured in such a way that when an object (a machine part under

manufacturing) appears at that specific location, a switch is turned ON which further turns the IoT camera ON for a duration of four minutes. The camera has a color image frame of size 1024x1024 pixels at the rate of 25 frames per second when it is turned ON. Each pixel can operate at 64 color levels. The IoT server is located far away from the camera on the Internet cloud provided by a service provider. Camera is connected to the local router with a CSMA/CD network of 100Mbps capacity.

a. Assume that the transport layer connectivity is carried over a network that faces a loss of 1 packet in 10000 packets. The round-trip time between the camera and the IoT server is about 100milli seconds. Default value of the segment size is 2048 bytes.
b. Will the TCP connection provide enough throughput for carrying the data generated by the camera? Estimate the throughput and prove your answer.
c. If your answer to (b) is No, then explain what happens to the data generated by the camera? How will the system work? Also suggest three possible ways to improve the situation.

5. **(5 points)** Provide detailed technical design of your innovative R&D product developed with the novelty of design elements, system architecture, and the performance obtained.

6. **(5 points)**
   a. What design considerations are required to be taken when designing a packet format for a protocol? Briefly explain with examples.
   b. Draw the header format of an IPv4 and UDP packet headers and explain the fields in brief.

----------All the best----------

Indian institute of Space Science and Technology
AV 341: Computer Networks Lab Exam

Date: 16/05/2023 **Final Exam** **Duration: 2.5 hr**

Name: Kamal Maurya SC Code: SC20B151

Q.CB1243: YourRDTF: Application Layer Reliable Data Transfer Protocol to retrieve sensitive data from a server.

Objectives:

a. To create an unreliable transport layer protocol session by establishing a User Datagram Protocol (UDP) client-server session and simulate packet loss over that UDP session.

b. To create a simple Application Layer protocol for reliable data transfer over the unreliable UDP transport.

c. To create a text file "data.txt" at the server side with stored text content with the following format:

*data.txt - Notepad

File Edit Format View Help

```
Title;Date;Information
Satellite communication;15-05-2023;A communication satellite is an artificial
satellite that transmits the signal via a transponder by creating a channel
between the transmitter and the receiver at different Earth locations./
Satellite edge computing;15-05-2023;Satellite edge computing refers to the use
of edge computing technologies at the edge of a satellite network, where data is
processed closer to the source rather than sending it back to the ground for
processing./
Space based hosting service;16-05-2023;Hosting an entire content server in a LEO
satellite to provide educational information to the remote location on Earth./
```

d. The client request with the title of content to the server and server searches for the title in the title column in the text file and returns the full content with date to the client.

e. The client displays the content to the user.

f. The request and response packets should follow the following packet format.

8 bit S. No.	4 bit Type	4 bit Options	16 bit P. len	32 bit Src. port no	32 bit D. port no.	256 Byte Payload

S. No.: Packet sequence number
Type: 1-Request message
2-Reply message
Option: 0
P. Length: Total packet length including header
Src. port no: Source port number
D. port no.: Destination port number
Payload: Can be title or content

Description of the Experiment:

You are required to develop a C-based application layer implementation as part of YourRDTF, a reliable data transfer (RDT) protocol. Create a C-based receiver (server) application that receives packets from a C-based application layer sender (client). The sender may send packets of certain size (as per given packet format) as per the requirement. The sender (client), after each packet transmission, may set a timer with a certain reasonable timeout value to receive acknowledgements in response to the data packets. If an acknowledgement is not received within that time, all the packets subsequent to the lost one is retransmitted. If an acknowledgment does arrive within the timeout, the timer is cancelled. Note that at any given time, the sender (client) has a limit in the number of unacknowledged packets (set a maximum of 5 packets for this limit). The sender (client) can use an integer sequence number on all data packets for ensuring in order delivery as well as matching the data packets and ACKs.

The receiver (server) receives data packets from the sender (client) and sends out an ACK for each packet correctly received. ACK packets may use sequence numbers to reflect the sequence number of the corresponding data packet. To simulate packet loss, the receiver (server) may reject/drop random packets. Randomly, one out of five packets (20% of packets) may be discarded by the receiver (server). When a packet is rejected, the sender (client) may timeout and retransmit all packets in the sequence from the last unacknowledged packet. The receiver (server) may display the packet sequence numbers on the screen and discard the contents of the packet after transmitting an acknowledgement with the corresponding sequence number. The sender (client) may also display the content of the packets received from the receiver (server).

The system should be designed and implemented such that multiple request packets can be sent to the server in sequence by the user typing in the title of the content and entering. The content text file at the server may have multiple entries to test the implementation. You can use either multi-threading or multi-process programming to achieve sending and receiving functions of both the server and client.

Server Implementation:

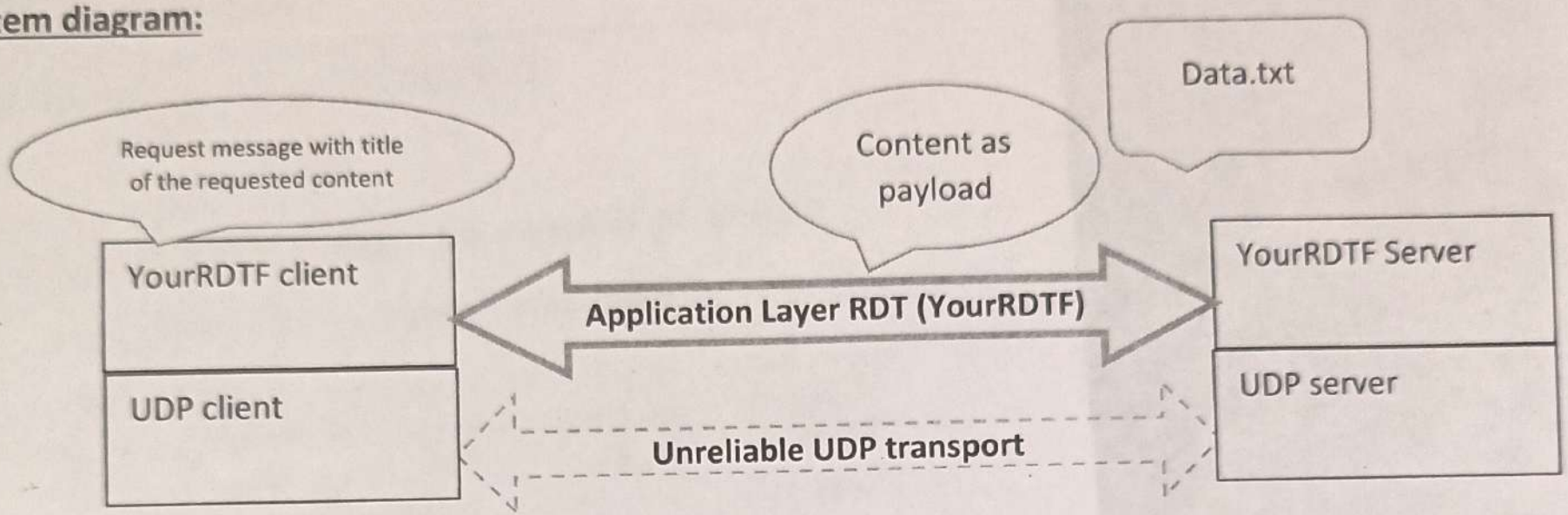
1. The server listens for incoming client requests on a specific port.
2. When a client's user types in a content title, client generates a request packet, and the server receives the request packet from the client.
3. The server extracts the title of the content from the request packet.
4. There are three information fields in the database which are terminated by '\' symbol. The information fields within the content is separated by ';'.
5. The server searches the database (text file) for the content with the matching title.
6. If the requested title is found in the database (text file), the server reads the entire content, related to the title, from the database and sends it to the client in the described packet format.
7. If the requested title is not found, the server sends a response packet indicating that the content is not found.
8. The server drops 20% of the packets it receives to simulates the packet loss and acknowledges all other packets by sending back UDP-based packets as acknowledgements.

Client Implementation:

1. The client communicates to the server on the specified port.
2. The client sends a request packet to the server containing the title of the content it wants to retrieve.
3. The client receives the response packet from the server.
4. The client decodes the response packet to identify the title, date, and content sections.

5. The client displays the date and content of the requested content on the screen.
6. The sender expects acknowledgements at the transport layer and if any acknowledgements are missing, then the corresponding packet and subsequent packets are quickly retransmitted.

The system diagram:



Note: In this implementation, we assume that the database already contains the information, and the server has access to it.

dt 3.0 + Multiprocess.

Indian Institute of Space Science and Technology
AV324 - Communication Systems II
Department of Avionics

Quiz 1 for B.Tech Semester VI on 22/02/2023

Note to the student

1. There are **4 questions** in this question paper on **1 page**, for a total of **15 marks**.
2. Answer **all** questions. State your assumptions clearly. Please write legibly.

Question 1 (3 marks): Briefly explain the three major challenges faced in a baseband point to point digital communication link (each challenge should be explained in at most two sentences). For each challenge briefly explain a method which can be used to mitigate that problem.

Question 2 (4 marks): Draw the block diagram of a baseband point to point digital communication link (consisting of the transmitter, channel, and receiver) which uses 4-PAM. Clearly state each block's function in the system. Using an example sequence of bits, clearly illustrate what is the signal at each point in the block diagram.

Question 3 (6 marks):

1. Define intersymbol interference in a baseband system.
2. Explain how sinc based pulse shaping is used to mitigate intersymbol interference.
3. Derive another pulse shape (in time domain) which can be used mitigate intersymbol interference.

Question 4 (2 marks): Assume that you have a baseband channel with a one sided bandwidth of 10 kHz. What is a modulation scheme that can transmit at a rate of at least 120 kbps (kilo bits per second) over this channel? Please write down the constellation as well as symbol time used.

End of question paper.

Indian Institute of Space Science and Technology
AV324 - Communication Systems II
Department of Avionics

Quiz 2 for B.Tech Semester VI on 06/04/2023

Note to the student

1. There are **3 questions** in this question paper on **2 pages**, for a total of **15 marks**.
2. Answer **all** questions. State your assumptions clearly. Please write legibly.

Question 1 (5 marks = $0.5 \times 4 + 1 + 2$): Consider a baseband communication system which uses a rectangular pulse shape of amplitude 1 and duration $T_b = 10s$ for signalling bits. Assume that the transmitter transmits a sequence 011010 of bits. In the following, for all the plots, please clearly label the x and y axes, also indicate the amplitudes for complete credit.

1. Draw the baseband line code at the transmitter assuming that transmission starts at a global time 0.
2. Assume that the baseband signal is transmitted through an ideal baseband channel without noise and without distortion. However, the channel introduces a delay of 3/4 seconds. Assuming that the receiver clock also starts at the global time 0, draw the received baseband line code at the receiver.
3. Assuming that the receiver does matched filtering, draw the signal after the matched filter.
4. Assuming that the receiver clock also starts at the global time 0, the receiver clock knows that T_b is 1s, but not the delay, make a separate plot showing the matched filtered output signal and the times at which samples are taken at the receiver. Note that no clock synchronization has been carried out. Also indicate the amplitudes of the samples that are obtained in the same plot.
5. Assume that early late gating is used at the receiver on the matched filter. Write down the early late update equation, with Δ being the time offset used for obtaining the early and late samples. Also denote the step size used in your algorithm by μ.
6. For $\Delta = 1$ and $\mu = 1$, derive the first three sample times obtained by the early late algorithm for the input sequence.

Question 2 (5 marks): Suppose a communication channel is modelled by a filter with impulse response $h(t)$. Assume that $h(t)$ is defined as

$$h(t) = \begin{cases} 1, \text{ for } 0 \leq t < T_b, \\ 0.5, \text{ for } T_b \leq t < 2T_b, \\ 0, \text{ otherwise.} \end{cases}$$

This channel is used by a baseband digital communication scheme in which the transmitter uses a rectangular pulse shape $p(t)$ of amplitude 1 and duration T_b. We assume that the output of this communication channel, when the input is a line code using $p(t)$, is fed into an equalizer with impulse response $q(t)$. The effective pulse shape from the input to the channel to the output is $g(t) = p(t) \star h(t) \star q(t)$ (here $\star$ denotes convolution). Suppose we require that at least,

$$\begin{aligned} g(0) &= 0, \\ g(T_b) &= 1, \\ g(2T_b) &= 1, \\ g(nT_b) &= 0, \text{ for } n = 3, 4; \end{aligned}$$

where T_b is the sampling period (or bit duration).

1. Design the equalizer impulse response $q(t)$ assuming that $q(t)$ is a tapped delay line filter (with delays of magnitude T_b). Note that the design should therefore specify the number and the values of the tap weights of the filter.

2. For a single pulse input (or a single bit input) draw the signal at the output of the equalizer. Clearly label the time and amplitude axes.

Question 3 (4 + 1 marks):

1. What is a Costas loop? Explain with the help of a block diagram.

2. What is the advantage of a Costas loop in comparison to other methods for phase/frequency synchronization in the context of coherent demodulation of a modulated signal like BPSK?

Rough work

AV324 - Class Test 2 (5 marks)

Name: Kamal Maurya
SC Code: SC20B151

3.5

1. (5 marks) Consider a baseband digital communication system that uses a rectangular pulse shape of duration Tb (the bit time) and amplitude 1 for transmitting a 1. The negative pulse shape is used for transmitting a 0.

a) Draw a representative eye diagram of the baseband signal at the transmitter (for a "random" sequence of 0s and 1s).

Assume that timing synchronization is achieved at the receiver for (b), (c), and (d)

b) Suppose the baseband signal is passed through a baseband channel with impulse response $\delta(t) + 0.6\delta(t - 1)$. Draw a representative eye diagram of the baseband channel output.

c) Now, suppose at the output of the channel we have a noise signal N(t) added to the channel output. The noise signal N(t) is IID and at every time N(t) is uniformly distributed in [-0.1,0.1]. Draw a representative eye diagram of the baseband channel output. Do you think the receiver will make errors in this case using the usual detector studied in class? (Answer Yes/No)

d) The noise signal N(t) is IID and at every time N(t) is uniformly distributed in [-0.5,0.5]. Draw a representative eye diagram of the baseband channel output. Do you think the receiver will make errors in this case using the usual detector studied in class? (Answer Yes/No)

Indian Institute of Space Science and Technology
AV324 - Communication Systems II
Department of Avionics

Final Exam for B.Tech Semester VI on 12/05/2023

Note to the student

1. There are **10 questions** in this question paper on **3 pages**, for a total of **50 marks**. The last page contains a table of Q function values.
2. Answer **all** questions.
3. Clearly state any assumptions that you are making. Unless explicitly stated, you can assume carrier, timing, and phase synchronization.
4. Credit will be given only for answers which are written legibly, clearly, and with complete steps.
5. **Your answer to a single question should be on contiguous pages of your answer sheet and should not be interleaved with other answers.**

Question 1 (4 marks): Suppose X and Y are two discrete random variables. Show from first principles that $|cov(X,Y)| \leq \sqrt{var(X)var(Y)}$.

Question 2 (8 marks): Consider the system shown in Figure 1. The input $N(t)$ is a white Gaussian noise process with zero mean and power spectral density $\frac{N_0}{2}$. The processes $N_1(t)$ and $N_2(t)$ are obtained by filtering $N(t)$ using the filters with impulse responses $h_1(t)$ and $h_2(t)$ respectively.

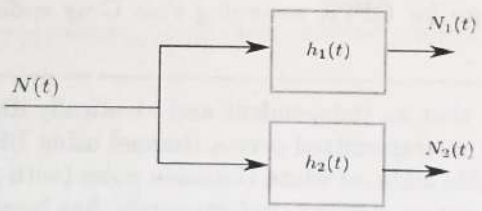


Figure 1: $N_1(t)$ and $N_2(t)$ are obtained via filtering of $N(t)$

Suppose the Fourier spectrums $H_1(f)$ and $H_2(f)$ for the two filters with impulse responses $h_1(t)$ and $h_2(t)$ are as shown in Figure 2. You can assume that the phase response is 0 for both filters for this question.

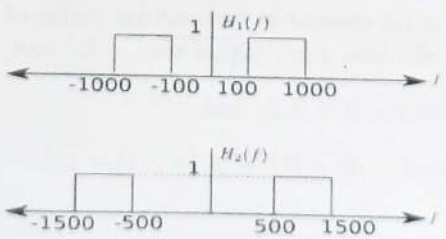


Figure 2: The spectrums $H_1(f)$ and $H_2(f)$

1. Derive the joint distribution of $N_1(t_1)$ and $N_2(t_2)$ where t_1 and t_2 are any two time instants.
2. Derive the joint distribution of $N_1(t_1)$ and $N_1(t_2)$ where t_1 and t_2 are any two time instants.

Question 3 (6 marks): Suppose B_n is an IID Bernoulli sequence, with $Pr\{B_n = 1\} = 0.5$. The sequence B_n is converted into a sequence A_n, where $A_n = 1$ if $B_n = 1$ and $A_n = -1$ if $B_n = 0$. A pulse amplitude modulated signal is then obtained as $P(t) = \sum_{n=-\infty}^{\infty} A_n h(t - nT_b)$ where T_b is the bit time, $h(t)$ is a rectangular pulse shape with unit amplitude and duration T_b. The $P(t)$ signal is passed through a channel modelled as an LTI system with impulse response $c(t) = \delta(t) + 0.5\delta(t - T_b)$ and which adds IID Gaussian noise $N(t)$ such that $N(t) \sim \mathcal{N}(0, \sigma^2)$. The output of the channel with $P(t)$ as input is denoted as $Q(t)$, i.e, $Q(t) = P(t) \star c(t) + N(t)$, where $\star$ denotes convolution. Assuming that symbol synchronization has been achieved, the received $Q(t)$ is sampled at the middle of each bit time in order to get the sequence Q_n. The sequence Q_n is then fed into a threshold detector with a threshold of zero, which produces the estimates $\widehat{B}_n$ of the transmitted bits B_n as output.

1. Derive the probability of bit error $Pr\left\{\widehat{B}_n \neq B_n\right\}$.

2. Derive the joint distribution $Pr\left\{\widehat{B}_n \neq B_n, \widehat{B}_{n+1} \neq B_{n+1}\right\}$.

Question 4 (5 marks): Suppose we are given an additive white Gaussian channel of total usable one sided bandwidth of 3 MHz, with an excess bandwidth of 50%. If the receiver noise figure is 7 dB, find the achievable bit rate, the $\frac{E_b}{N_0}$ required for a BER of 10^{-8}, and the receiver sensitivity assuming that QPSK is used for modulation. (Use Table 1 which contains Q function values to help you with this computation).

Question 5 (4 marks): Using the nearest neighbours approximation, find out the average symbol error probability of 16-QAM modulation demodulation scheme. Clearly state all assumptions.

Question 6 (3 marks): Define bit error rate and symbol error rate. Derive the relationship between bit error rate and symbol error rate for QPSK assuming that Gray coding is used to map bits to signal constellation points.

Question 7 (6 marks): Assume that an independent and identically distributed bitstream $(B_1, B_2, \ldots)$, with each bit B_i chosen uniformly, is transmitted over a channel using BPSK with received energy per bit E_b. We assume that the channel adds additive white Gaussian noise (with power spectral density $\frac{N_0}{2}$) to the received signal. The coherent correlation receiver, unfortunately, has been designed as a BFSK correlation receiver (with one frequency being the same as the carrier frequency of the BPSK signal, and the other as an orthogonal frequency) to decode BFSK signals which are assumed to use a received energy per bit of $0.5E_b$. Obtain the average probability of symbol error when this correlation BFSK receiver is used to decode the received BPSK signal. Express your answer in terms of the Q or erfc functions.

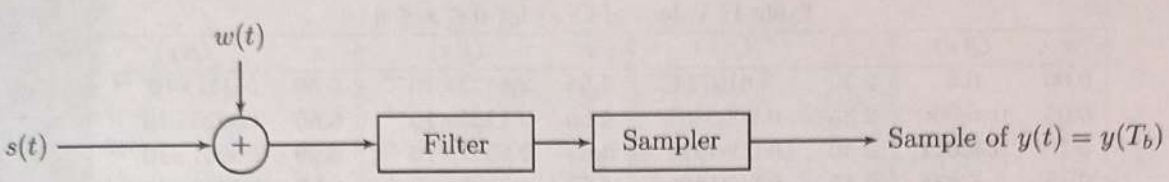
Question 8 (4 marks): Suppose $p_1(t)$ denote a rectangular pulse of unit duration, i.e, $p_1(t) = 1$, for $t \in [0, 1]$ and 0 for any other t. Consider two 4-ary signal sets as follows:

1. signal set A: $s_i(t) = p_1(t - i)$, for $i = 0, 1, 2, 3$, and

2. signal set B: $s_0(t) = p_1(t) + p_1(t - 3), s_1(t) = p_1(t - 1) + p_1(t - 2), s_2(t) = p_1(t) + p_1(t - 2)$, and $s_3(t) = p_1(t - 1) + p_1(t - 3)$.

Find out signal-space representations for each signal set. If possible, the orthonormal basis for the two signal sets should be chosen to be the same set of signals.

Question 9 (5 marks): Consider the following system:



Here $s(t)$ is a time-limited finite-energy signal in the time interval $[0, T_b]$ (i.e. $s(t)$ is zero outside the interval $[0, T_b]$) and $w(t)$ is a zero mean white Gaussian noise process with power spectral density $\frac{N_0}{2}$. The sampler block samples the output of the filter at time T_b. Derive the response of the filter which is used to maximise the SNR of $y(t)$ at the sampling instant T_b. What is this maximum SNR at the sampling instant T_b?

Question 10 (5 marks): Suppose a digital source puts out a sequence of bits $(B_1, B_2, \dots)$. The sequence of bits is modelled by an IID random process where each bit B_i is a Bernoulli random variable taking values 0 and 1 with equal probability.
Draw the block diagram of a QPSK modulator which takes this bit sequence as input and produces a QPSK signal $s(t)$. The modulator uses a carrier frequency of f_c and the energy per bit of E_b. Suppose the QPSK signal $s(t)$ is passed through a passband channel centered at f_c with appropriate bandwidth. Draw the block diagram of a QPSK demodulator and detector which receives the channel output and detects the transmitted bit stream from the channel output.

Best of luck !

Kamal

Indian Institute of Space Science and Technology
Department of Avionics
AVM 862 RF Integrated Circuits
Quiz 1

Time: 1 hour **Max. marks:** 15

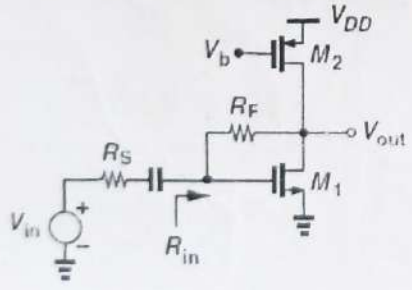
Answer all the questions

1. Consider an RF frontend which consists of a band pass filter and a low noise amplifier and a mixer. The band pass filter has a loss of 1 dB. The low noise amplifier has a gain of 12 dB and a noise figure of 1.8 dB. The mixer has a gain of 5 dB and a noise figure of 3.5 dB. Calculate the noise figure of the total system. *Hint: The numbers given in this question are in decibels. Convert them to normal power ratio quantities before proceeding with the calculations.*(4 marks)

2. Design a high-pass L-match network which can convert 50 Ω to 20 Ω at 5 GHz. (4 marks)

3. An LNA senses a -80 dBm signal at 2.410 GHz and two -40 dBm interferers at 2.420 GHz and 2.430 GHz. The LNA has a linear gain of 10 dB. What IIP3 is required if the IM products must remain 20 dB below the signal at the output of the LNA? Assume 50Ω interfaces at the input and output. (3 marks)

4. Derive the noise figure of a resistive feedback LNA. If $\gamma = 1$, $g_{m1} = 20$mS, $g_{m2} = 7$ mS, $R_s = 50\ \Omega$, $R_F = 5$K Ω, what is the noise figure? [*Hint:* $R_{in} = 1/g_m$, $R_{out} = (R_F + R_s)/2$.] (4 marks)



Indian Institute of Space Science and Technology
Department of Avionics
AVM 862 RF Integrated Circuits
Quiz 2

Time: 1 hour **Max. marks:** 15

Answer all the questions

Some useful formulae:

$$I_D = \frac{\mu C_{ox}}{2}\frac{W}{L}(V_{GS} - V_{TH})^2$$

$$g_m = \mu C_{ox}(W/L)(V_{GS} - V_{TH}) = \sqrt{2I_D \mu C_{ox}(W/L)} = \frac{2I_D}{(V_{GS} - V_{TH})}$$

The fourier expansion of a square wave with 50% duty cycle toggling between -1 and +1 is:

$$s(t) = \frac{4}{\pi}\sum_{n=1,3,5..}^{\infty}\frac{1}{n}\frac{sin(n\pi t)}{T}$$

1. Consider a common source with inductive degeneration LNA. The bondwire inductance of 2 nH is used as the source inductor, and a device of size $1\mu m/60nm$ is used with a C_{gs} of 5fF. $\mu_n C_{ox} = 0.25\text{mA}/V^2$, $V_{THN} = 0.35\text{V}$.

   (a) Derive the expression for the input impedance (2 marks)

   (b) What is the g_m required for the input match to be done for a source impedance of 50 Ω? Using the square-law behaviour of the MOS device, what is the gate bias voltage that is required? (1 mark)

   (c) What is the gate inductor that is required to be used, if the circuit is expected to be tuned at 5 GHz? (1 mark)

   (d) In order to switch the gain of the LNA to a lower value, devise a scheme which can accomplish it without affecting the input match severely. Assume that a pair of digital signals GL and $\overline{GL}$ are provided. When GL is high, the gain has to be reduced. (2 marks)

2. A heterodyne receiver is designed for two cases: (1) LO is far from RF. The image frequency lies outside the bandwidth of the LNA. (2) LO is close to the RF. The image frequency also lies inside the bandwidth of the LNA. If there is no signal in the image frequency and only thermal

noise is to be considered, which of the two cases would have lower noise at the output of the downconversion mixer? Draw the spectrum and show how the noise adds up. (3 marks)

3. Draw a single balanced passive upconversion mixer. You can model the input impedance of each arm of the driver amplifier as a capacitor and a resistor in parallel. In order to tune it at the desired RF frequency, you can add an inductor in parallel. For analysis, you can consider that the passive mixer is driving a resistive load. Derive the conversion gain for this mixer. If quadrature mixing is required, how should the LO waveforms be? Draw the revised circuit for a quadrature upconversion mixer. (3 marks)

4. Draw a Class AB differential power amplifier with a balun to drive the load. Consider an input differential sinewave signal with a peak-to-peak amplitude of 400 mV with a DC bias of 400 mV. Let VTH of the transistor be 380 mV. Sketch the drain current, drain voltage and output voltage. (3 marks)

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY

VLSI Technology (AV 323)
Electronics and Telecommunication Engineering (VI SEM)
Quiz 1: Total Marks 15
Date: 17-02-2023
You are allowed to make assumptions with proper justification. There are no part marking.

1. Derive the expression for threshold voltage (Vt) of an ideal MOS structure. Draw the charge vs. gate voltage diagram and explain the entire region (accumulation, depletion and Inversion) in detail.

Marks: (3+2).

2. A MOS capacitor having the gate oxide thickness t_{ox}=100nm and substrate Boron Doping density $10^{15}/cm^3$ is biased in Depletion mode with a gate Voltage Vg. If the surface potential is 0.2 V for this bias condition, determine the followings
   a. Peak Electric Field in the Si substrate
   b. Electric Field in the Oxide
   c. The gate Voltage Vg

Marks: (3+1+1).

3. For the MOS capacitor of Question 2, find out gate-to-substrate capacitance per unit area when
   a. Surface potential is 0V.
   b. Surface potential is 0.4V

Marks: (2.5+2.5)

Given:

$\varepsilon o = 8.854 \times 10\text{-}14$ F/cm

εs=12 for Silicon

Intrinsic carrier concentrations of Si is $1.5 \times 1010/$ cm3

εox=4 for SiO2

Surface potential and Si potentials are similar.

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY

VLSI Technology (AV 323)
Electronics and Telecommunication Engineering (VI SEM)
Quiz 2: Total Marks 15
Date: 31-03-2023

You are allowed to make assumptions with proper justification. There is no part marking. If there is any mistake in the unit or there is a significant step jump, the mark will be considered Zero.

1. Derive the expression of best possible subthreshold slope which can be achieved at 500K.

Marks: 4

2. Consider a transistor with following parameters:
   i. The transistor has a sub threshold slope which is 100mV/decade and V_t is 0.3V at Room Temperature. If the On current is 1mA/μm, then **what is the OFF state current?**
   ii. Suppose the transistor is cooled down to 100°K then **what is the sub-threshold slope?** Kindly note that at low temperature, the Vt value also increases slightly due to bandgap widening. Suppose the new Vt value at 100°K is 0.32V and the On current is 1.5mA/μm. **Then what would be the OFF state current?**

Marks: (3+3).

3. What is the DIBL of Short Channel Transistor? What is the unit of DIBL? Explain the DIBL with a Band diagram. Kindly note that proper explanations should be there along with detailed figures.

Marks: (1+1+3).

Given:

εo =8.854 ×10-14 F/cm

εs=12 for Silicon

Intrinsic carrier concentrations of Si is 1.5 ×1010/ cm3

εox=4 for SiO2

Surface potential and Si potentials are similar.

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY

VLSI Technology (AV 323)
Electronics and Telecommunication Engineering (VI SEM)
Assignment: Total Marks 20
Date: 17-04-2023

You are allowed to make assumptions with proper justification. There is no part marking. If there is any mistake in the unit or there is a significant step jump, the mark will be considered Zero.

1. A MOS capacitor has metal gate with 5.17eV work function, 100nm SiO_2 and n type Silicon substrate with doping $10^{16}/cm^3$.
   a. If the oxide is having positive fixed oxide charge density of $10^{11}/cm^2$ then calculates the flat band voltage.
   b. Sketch the band diagram when -0.5 V is applied to gate terminal, with substrate.
   c. Sketch the electric field from gate region, going through oxide and into Si (Construct X-Y graph with Electric field on Y axis and distance from gate , going down into substrate, on X axis). There is no need to compute magnitude of electric field; however, you should plot an accurate qualitative representation of electric field behavior.
   d. Corresponding to this the electric field, construct an X-Y graph with Charge density on Y axis and distance from gate on X axis.
   a) State and justify (with proper reasons) whether the MOS capacitor is an accumulation, depletion, weak inversion or strong inversion region.

Mark: 4+4+4+4+4

1. Given:

εo =8.854 ×10-14 F/cm

εs=12 for Silicon

Intrinsic carrier concentrations of Si is 1.5 ×1010/ cm3

εox=4 for SiO2

Surface potential and Si potentials are similar.

4.956
0.5

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY

VLSI Technology (AV 323)
Electronics and Telecommunication Engineering (VI SEM)
End-Sem Exam: Total Marks 50
Date: 01-05-2023

You are allowed to make assumptions with proper justification. There is no part marking except the process flow. If there is any mistake in the unit or there is a significant step jump, the mark will be considered Zero.

1. The MOS is operating in Depletion mode. Show that the total capacitance of the MOS is

$$C = \frac{C_{OX}}{\sqrt{1 + \frac{2C_{OX}^2 V_G}{qN_A\varepsilon_0\varepsilon_S}}}$$

Instruction: No step Jump.

Marks: 5

2. A MOS capacitor is fabricated on a P-Type Si with doping concentrations =4.5 $\times 10^{15}/cm^3$. The Gate oxide thickness is 0.1μm with heavily doped Poly-Si in which the Fermi level can be approximated to be in the conduction band at Ec+0.05eV. The electron affinity of Poly-Si is 4.05eV. Determine the following parameters:
   - **a.** Ideal Threshold voltage
   - ***b.*** The threshold voltage, including the effect of Flat band voltage. The density of fixed oxide charge is $2 \times 10^{11}/cm^2$
   - ***c.*** Determine the threshold voltage, including the effects of flat band voltage, if the substrate doping is $1.5 \times 10^{16}/cm^3$
   - ***d.*** Determine the threshold voltage, including the effects of flat band voltage, if the thickness of the oxide changes to 0.05 μm.

Mark: 2.5+2.5+2.5+2.5

3. Derive the expression of dose for ion implantation. Assume that the SiO_2 and polysilicon layers have the same ion stopping power as Si, and that SiO_2 thickness is 60 nm (straggle is 23 nm). What ion implantation dose is required to achieve a peak concentration of 10^{19} cm^{-3} of Arsenic at the SiO_2 and Si interface in the source/drain regions?

Mark: 5 +3

4. Consider a short channel C-MOS transistor with technology node 45 nm
   a. What is the difference between DIBL and Threshold voltage swing? Write only points.
   b. How is this resolved (both DIBL and Threshold voltage swings)?

   [Give a detailed process flow with recipes for C-MOS with LOCOS. Draw the cross-sectional schematic in one column and provide the process description in the other column. The justification should be there against every process step.

   [Hints: Source & Drain Engineering with different doping levels and profiles.

   Similarly, Channel engineering with Halo implantation for CMOS, Metal contact gate, LOCOS]

Marks: 2+20

5. Explain the lift-off process of Photolithography to deposit Metal.
   [Give a detailed process flow with recipes for the lift-off process. Draw the cross-sectional schematic in one column and provide the process description in the other column. The justification should be there against every process step.]

Marks: 5

END

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY, TRIVANDRUM
DEPARTMENT OF HUMANITIES, QUIZ 1, FEBRUARY 2023
HS 321: PRINCIPLES OF MANAGEMENT SYSTEMS

Maximum Marks: 15 **Time allowed: 1 hour**

Note: All questions carry equal marks

1. Discuss in detail the concept of social systems approach to management. Describe how it assumes importance in the context of R&D organizations.

2. Five lathes ae to be allotted to five operators (one for each). The following table gives output figures in (in pieces):

	Hourly output in Lathe				
Operator	**L_1**	**L_2**	**L_3**	**L_4**	**L_5**
P	20	22	27	32	36
Q	19	23	29	34	40
R	23	28	35	39	34
S	21	24	31	37	42
T	24	28	31	36	41

Profit per piece is Rs.250. Find the assignment of operators to the lathes for maximum profit per hour.

3. A drugs manufacturer makes three types of drugs: Drug A, Drug B and Drug C. Processing of these drugs is done on three machines, M1, M2 and M3. Drug A requires 2 hours on machine M1 and 3 hours on machine M3. Drug B requires 3 hours on machine M1, 2 hours on Machine M2 and 2 hours on machine M3. Drug C requires 5 hours on machine M2 and 4 hours on machine M3. There are 8 hours of time per day available on machine M1, 10 hours of time available on machine M2 and 15 hours of time per day available on machine M3. The profit gained from one unit of Drug A, Drug B and Drug C is Rs.3, Rs.5 and Rs.4 respectively. Formulate the above a linear programming problem and solve it using simplex method. {Use fractions to populate the Simplex Table}.

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY, TRIVANDRUM
DEPARTMENT OF HUMANITIES
HS 321: PRINCIPLES OF MANAGEMENT SYSTEMS
QUIZ: 2, APRIL 2023

Maximum marks: 15 **Time: 60 Minutes**

Note: 1. All questions are compulsory. Answer the questions in a sequence to the extent possible.
2. All questions carry equal marks.

1. A dietician in a hospital is to arrange a special diet using three goods P, Q, and R. Each gram of food P contains 20 units of Calcium, 10 units of Iron, 10 units of Vitamin A, 20 units of Cholesterol. Each gram of Q contains 10 units of Calcium, 10 units of Iron, 20 units of Vitamin A and 24 units of Cholesterol. Each gram of R contains 10 units of Calcium, 10 units of Iron, 10 units of Vitamin A and 18 units of Cholesterol. If the minimum daily requirement are 300 units of Calcium, 200 units of Iron and 240 units of Vitamin A, how many grams of each food should be used to meet the minimum requirements and at the same time minimize the cholesterol intake. What is the minimum cholesterol intake?

2. (i) Explain the concept of hierarchy of objectives.

   (ii) A large organization consults you for introducing management by objectives. What steps will you advise the organization to take for successful introduction and operation of MBO?

3. With a neat diagram explain the features of line and staff organization. What are their advantages and disadvantages?

*****ALL THE BEST*****

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY, TRIVANDRUM
DEPARTMENT OF HUMANITIES
END SEMESTER EXAMINATIONS, MAY 2023
HS 321: PRINCIPLES OF MANAGEMENT SYSTEMS

Maximum Marks: 50 **Time allowed: 3 hours**

1. **This question paper consists of 2 pages and has two parts, Part A and Part B.**
2. **Answer all the questions in sequence to the maximum possible extent.**
3. **All questions in Part A carry 5 marks each.**
4. **In Part B, marks are given against each question.**
5. **Supplement your answers with appropriate diagrams and examples.**

PART - A

1. Discuss the programmed and non-programmed decisions managers face with industrial examples for each.
2. What is the span of control? Discuss the factors affecting the span of control in an organization with examples.
3. With a diagram discuss how organizations plans be arranged in a hierarchy achy Discuss the concept of the hierarchy of organizational objectives.
4. Discuss the motivation theory that best describes an individual's perceived fairness in employment.
5. Discuss the bases of power in organizations with examples.

PART - B

6. A machine operator must perform two operations on several jobs, first turning and then threading. The time required to perform these operations (in minutes) for each job is known.

Job	Time for turning (minutes)	Time for threading (minutes)
1	3	8
2	12	10
3	5	9
4	2	6
5	9	3
6	11	1

(i) Determine the order in which the jobs should be processed to minimize the time required to complete all the jobs. (2 marks)
(ii) What is the idle time of turning and threading operations? (1 mark)
(iii) Draw the Gantt chart for the above. (1 mark)

7. A farmer has a 100-acre farm. He can sell all the tomatoes, lettuce or radishes that he produces in his farm. The price he can obtain is Rs.1 per kg of tomatoes, Re.0.75 a head for lettuce and Rs.2 per kg of radishes. The average yield per acre is 2000 kg of tomatoes, 3,000 heads of lettuce and 1000 kg of radishes. Fertilizer is available at Rs.0.5 per kg, and the amount required per acre is 100 kg each for tomatoes and lettuce and 50 kg for radishes. Labour required for sowing, cultivating and harvesting per acre is 5 man-days for tomatoes and radishes and 6 man-days for lettuce. A total of 400 man-days of labour are available at Rs.20 per man-day. Formulate a Linear programming model for the above and solve using the simplex method. (6 marks)

8. A diary firm has four plants located throughout the state. Daily milk production at each plant is as follows: Plant 1: 30 million liters, Plant 2: 50 million liters, Plant 3: 75 million liters, Plant 4: 20 million liters. Each day the diary firm must fulfill the needs of its six distribution centers. The minimum requirement at each center is as follows: Distribution Center 1: 20 million liters, Distribution Centre 2: 40 million liters, Distribution Centre 3: 30 million liters, Distribution Centre 4: 10 million liters, Distribution Centre 5: 50 million liters, and Distribution Centre 6: 25 million liters. The cost of shipping one million liters of milk from each plant to each distribution center is given below:

		Distribution Centers						
		D1	D2	D3	D4	D5	D6	
Plants	P1	1	2	1	4	5	2	30
	P2	3	3	2	1	4	3	50
	P3	4	2	5	9	6	2	75
	P4	3	1	7	3	4	6	20

Determine the optimal solution for the diary firm to decide how much the shipment should be from each plant to each distribution center so that the shipment cost is minimized. (6 marks)

9. A project has seven activities. All activities' normal time, crash time, normal cost, and crash cost are given. The overhead cost is Rs.600 per day. Establish the time-cost relationship and find out the least cost duration of the project.

Activity	Predecessor(s)	Normal Time (days)	Normal Cost (Rs)	Crash Time (days)	Crash Cost (Rs)
A	-	5	2000	3	2400
B	-	14	4200	10	4600
C	A	6	3000	4	3400
D	B	4	2600	4	2600
E	C,D	12	2400	8	2800
F	B	10	4000	8	5000
G	B, F	6	3000	4	3400

Also, draw its associated graph. (5 marks)

10. A project consists of 12 activities. The interrelationship among activities is as follows:

Activity	Predecessor(s)	Duration (Days)	Activity	Predecessor(s)	Duration (Days)
A	-	4	G	B	8
B	-	14	H	C	12
C	-	16	I	D, E	4
D	A	6	J	D, E	14
E	B	12	K	B, F, H	12
F	B	20	L	G, I	13

For the above data, draw the project network and find its critical path. Find out all activities' total, free, interfering and independent floats. (5 marks)

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM, 695 547

B.Tech VI Semester ECE

AV 477 - RadarSystems

Time: 1 hour Date: 16/02/2023 Max. Marks: 15

Answer the following Question

1. A C-band radar operating at a frequency of 4 GHz with an antenna having a gain of 45 dB transmits a peak power of 50 kW. Assume a total system loss of 2 dB. For a target located at a range of 100 km, find the minimum radar cross section to produce an available received signal power of $Pr = 2 \times 10^{-12} W$. [3]

2. Explain how Matched filter increases the SNR of the received echo pulse of a single moving target (prove through derivation). [5]

3. Explain for a given probability of a False alarm, how the probability of detection can be increased for detecting the target in Gaussian noise. [2]

4. Consider an S-band Pulsed radar transmitting 250kW of peak power with a pulse width of $1.5\mu s$ and a PRF of 500pps. The radar is transmitting at a frequency of 3GHz.[5]

   (i) Calculate the maximum unambiguous range of this radar, range resolution, and duty factor.

   (ii) Calculate the average transmitted power and the energy radiated in the first 10ms.

   (iii) Calculate the Doppler shift for a target approaching the radar with a radial velocity of 30m/s.

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM, 695 547

B.Tech VI Semester ECE

AV 477 - RadarSystems

Quiz -2

Time: 1 hour Date: 30/03/2023 Max. Marks: 15

Answer the following Question

1. Define MTI improvement factor. [2]
2. What do you mean by blind speed? Explain how to increase the blind speed region. [4]
3. What do you mean array factor and what is the directive gain for N linear phased array antenna [2]
4. Consider a pulse Doppler radar that uses two PRFs to resolve range ambiguity. If the desired unambiguous range is 200 km, find the unambiguous ranges for the two PRFs. Select the integer N = 7. [2]
5. What do you mean by pulse compression and what is its significance of it? [2]
6. Consider an LFM pulse compression radar operating at Ku-band using a 200 ns pulse that is compressed with a compression ratio of 100. Find the chirp bandwidth and the range resolutions due to uncompressed and compressed pulses. [3]

$C.R = \frac{\tau}{\tau_c}$

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM, 695 547

B.Tech VI Semester ECE

AV 477 - RadarSystems

End Semester Examination - May 2023

Time: 3 hour Date: 09/05/2023 Max. Marks: 50

Answer the following Question

1. A low PRF radar with a pulse repetition frequency of 10 kHz radiates 10 kW of peak power. The duty cycle is 20%. [4]
   (i) Calculate the average transmitted power, pulse repletion interval, width of the pulse, and the pulse energy radiated in the first 20 ms.
   (ii) What is the maximum unambiguous range?
   (iii) Calculate the corresponding range resolution and the required bandwidth

2. A spaceship in lunar orbit (orbit distance is $3.8 \times 10^8 m$) employs an L-band radar to transmits an average power of 3 MW isotropically with an antenna operating at 3000 MHz. [4]
   (i) Find the power density at the surface of the earth.
   (ii) Find the time it takes for the signal to travel from the spaceship to the Earth.
   (iii) Find the power received by a receiver on the earths surface with a 50-inch diameter dish antenna. Assume a lossless transmission.

3. (i) Derive the single pulse radar equation. [4]
   (ii) A high PRF radar operating at 5.4 GHz transmits a peak power of 10 kW and has the following parameters: antenna gain G = 20 dB, overall loss L = 10 dB, noise figure F = 3 dB, time on target Ti = 2.5 s, duty factor dt = 0.25, radar cross section $\sigma = 0.02m^2$. For target range R = 45 km, find the single pulse SNR. [3]

4. (a.) Explain how to convert MIMO channel to SISO channel with derivation. [4]
   (b.) What is the optimal beamforming vector for $N_r \times N_t$ MIMO system, if $N_r > N_t$? Maximum how many beams can be formed if the rank of the channel is r and what are the beamforming vectors? [2]
   (c.) Draw the block-level implementation of Hybrid beaming system. [4]

5. (a.) Explain the double delay line canceller with block and transfer function. Explain the need for double delay line canceller in radar applications. [4]
   (b.) Explain the need for a staggered pulse radar. [4]

(c.) Consider a pulse Doppler radar that uses two PRFs to resolve range ambiguity. If the desired unambiguous range is 200 km, find the unambiguous ranges for the two PRFs. Select the integer N = 7. [2]

6. (a.) Explain how linear FMCW signal is used to detect the range of the target using sufficient equation [4]

(b.) Consider a certain radar that uses a stretch processor to process an extremely high bandwidth of 450 MHz in an LFM pulse compression radar. It transmits a pulse of length 30 s to perform the detection of two resolvable targets with a range receive window of 750 m. Assume that one of the targets is located at a range of 15 km. Find the frequency tones corresponding to the above targets. [3]

(c.) Explain what is the need for pulse compression radar with sufficient equation [3]

7. (a.) Define the ambiguity function and explain the use of the ambiguity function in radar. [2]

(b.) What do you mean by the probability of false alarm (PFA) and what is the relation between PFA and probability of detection for AWGN noise system? [3]