Progressive Education Society's

Modern College of Engineering

Department of Electronics & Telecommunication Engineering

Curriculum Booklet
Second Year
2019-Pattern
Semester -II

Vision of Institute

"To create a collaborative academic environment to foster professional excellence and ethical values"

Mission of the Institute

1. To develop outstanding engineers & professionals with high ethical standards capable of creating and managing global enterprises.
2. To foster innovation and research by providing a stimulating learning environment.
3. To ensure equitable development of students of all ability levels and backgrounds.
4. To be responsive to changes in technology, socio-economic levels and environmental conditions.
5. To foster and maintain mutually beneficial partnerships with alumni and industry.

Vision of Department

To impart holistic Education in Electronics and Telecommunication Engineering to create engineers equipped to meet the challenges of a dynamic, global environment

Mission of Department

1. To impart quality Education in the field of Electronics, Communication and Signal processing, by providing a comprehensive learning experience.
2. To provide avenues to encourage students to continue education in diverse fields.
3. To develop competent Engineers, well-versed in multi-disciplinary fields.
4. To inculcate ethical and professional values in our students to endow society with responsible citizens.

Program Educational Objectives

The graduates of Electronics and Telecommunication Engineering Department of P.E. S's MCOE will

1. Apply design and development skills related to E&TC Engineering to solve real life problems
2. Pursue careers as Entrepreneurs, Engineers or Managers in Private/Government sectors or continue their education in the same or multi-disciplinary fields.
3. Practice ethical standards, adhere to social responsibilities and lead teams of professionals in the global environment.

Program Specific Outcomes

At the time of graduation, the students of the ENTC department of PES's MCOE, will be able to

1. Apply the Knowledge in E&TC engineering to understand, evaluate, design, or implement the electronics, communication, embedded or information systems or sub- systems using conventional or modern tools/techniques
2. Take up jobs in Government or private sectors, undertake research, create jobs or pursue further studies in any of the fields of E&TC, in India or Abroad.
3. Incorporate ethical & social responsibility to complete projects in the E&TC and allied fields and use effective written and oral communication skills to present the work.

Program Outcome

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2.Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3.Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4.Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5.Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6.The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11.Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12.Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Structure

Savitribai Phule Pune University, Pune
S.E. (Electronics / E&TC Engineering) 2019
Course
(With effect from Academic Year 2020-21)

Semester-IV

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme andMarks						Credit			
		Theory	Practical	Tutorial	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR	TUT	Total
204191	Signals & Systems	03	-	01	30	70	25	-	-	125	03	-	01	04
204192	Control Systems	03	-		30	70		-	-	100	03	-	-	03
204193	Principles of Communication Systems	03	-	-	30	70	-	-	-	100	03	-	-	03
204194	Object Oriented Programming	03	-	-	30	70	-	-	-	100	03	-	-	03
204195	Signals & Control System Lab		02				50			50		01		01

204196	Principle of Communication Systems Lab	-	02	-	-	-	-	50	-	50	-	01	-	01
204197	Object Oriented Programming Lab	-	02	-	-	-	-	-	50	50	-	01	-	01
204198	Data Analytics Lab		02				-		25	25		01		01
204199	Employability Skill Development	02	02	-	-	-	50	-	-	50	02	01	-	03
204200	Project Based Learning ᵑ	-	04				50		-	50		02		02
204201	Mandatory Audit Course 4[&]	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		**14**	**14**	**01**	**120**	**280**	**175**	**50**	**75**	**700**	**14**	**07**	**01**	**22**

Abbreviations:
In-Sem: In semester End-sem: End semester TH : Theory TW : Term
WorkPR : Practical OR : Oral TUT : Tutorial

Note: Interested students of S.E. (Electronics/E&TC) can opt any one of the audit course from the list of auditcourses prescribed by BoS (Electronics & Telecommunications Engineering)

1. Name of the Course - Signals & Systems (204191)

Weekly Work Load (in Hrs/week)	Lecture	Tutorial	Practical
	3	1	1

Online/ In-sem	Theory	Practical	Oral	Term-work	Total Marks	Credit
30	70	-	-	25	125	4

1.1 Syllabus

Unit I : Introduction to Signals and Systems **(7L)**

Signals: Introduction, Graphical, Functional, Tabular and Sequence representation of Continuous and Discrete time signals. Basics of Elementary signals: Unit step, Unit ramp, Unit parabolic, Impulse, Sinusoidal, Real exponential, Complex exponential, Rectangular pulse, Triangular, Signum, Sinc and Gaussian function.

Operations on signals: time shifting, time reversal, time scaling, amplitude scaling, signal addition, subtraction, signal multiplication. Communication, control system and Signal processing examples.

Classification of signals: Deterministic, Random, periodic , Non periodic, Energy , Power, Causal , Non-Causal, Even and odd signal.

Systems: Introduction, Classification of Systems: Lumped Parameter and Distributed Parameter System, static and dynamic systems, causal and non-causal systems, Linear and Non- linear systems, time variant and time invariant systems, stable and unstable systems, invertible and non- invertible systems.

Unit II : Time domain representation of LTI System **(7L)**

Input-output relation, definition of impulse response, convolution sum, convolution integral, computation of convolution integral using graphical method for unit step to unit step, unit step to exponential, exponential to exponential, unit step to rectangular and rectangular to rectangular only. Computation of

convolution sum. Properties of convolution. System interconnection, system properties in terms of impulse response, step response in terms of impulse response.

Unit III : Fourier Series **(7L)**

Fourier series (FS) representation of periodic Continuous Time (CT) signals, Dirichlet condition for existence of Fourier series, orthogonality, basis functions, Amplitude and phase response, FS representation of CT signals using trigonometric and exponential Fourier series. Applications of Fourier series, properties of Fourier series and their physical significance, Gibbs phenomenon.

Unit IV : Fourier Transform **(7L)**

Fourier Transform (FT) representation of aperiodic CT signals, Dirichlet condition for existence of Fourier transform, evaluation of magnitude and phase response, FT of standard CT signals, Properties and their significance, Interplay between time and frequency domain using sinc and rectangular signals, Fourier Transform for periodic signals.

Unit V: Laplace Transform **(7L)**

Definition of Laplace Transform (LT), Limitations of Fourier transform and need of Laplace transform, ROC, Properties of ROC, Laplace transform of standard periodic and aperiodic functions, properties of Laplace transform and their significance, Laplace transform evaluation using properties, Inverse Laplace transform based on partial fraction expansion, stability considerations in S domain, Application of Laplace transforms to the LTI system analysis.

Unit VI : Probability and Random Variables **(7L)**

Probability: Experiment, sample space, event, probability, conditional probability and statistical independence, Bayes theorem, Uniform and Gaussian probability models.

Random variables: Continuous and Discrete random variables, cumulative distributive function, Probability density function, properties of CDF and PDF. Statistical averages, mean, moments and expectations, standard deviation and variance.

1.2 Course Objectives

1. To Elaborate the Classification and different operations on signals.
2. To Describe the classification of Systems based on their Input-output relations and Impulse response.
3. To Illustrate the computation of LTI System response using Convolution Integral and Convolution Sum.
4. To Explain the analysis of signals in time and transform domain.
5. To Introduce the basis of random variables to compute the probability and statistical parameters

1.3 Course Outcomes

At the end of the course the Student will be able to:

1. Perform the classification and different operations on signals. (Unit: I, BTL 2: Understand)
2. Categorize the Systems based on their Input-output relations and Impulse response. (Unit: I, II, BTL 2: Understand)
3. Obtain the response of LTI Systems using Convolution Integral and Convolution Sum. (Unit: II, BTL 2: Understand)
4. Analyze the signals using Fourier series, Fourier Transform and Laplace Transform. (Unit: III, IV, V, BTL 2: Understand)
5. Compute the probability of given event and different statistical parameters of Random Variables. (Unit: VI, BTL 2: Understand)

1.4Text Books

1. Simon Haykins and Barry Van Veen, "Signals and Systems", 2nd Edition, Wiley India.
2. M.J. Roberts "Signal and Systems", Tata McGraw Hill 2007.

1.5 Reference Books

1. Charles Phillips, "Signals, Systems and Transforms", Pearson Education, 3rd Edition.

2. Peyton Peebles, "Probability, Random Variable, Random Processes", 4th Edition, Tata McGraw Hill.

3. A. NagoorKanni "Signals and Systems", 2nd edition, McGraw Hill.

1.6 Reference Web Links/ Research Paper/ Referred Book other than Mention in Syllabus:

E1. Alan Oppenheim, "Signals & Systems", 2nd edition, PHE India

E2. Shaila Apte, "Signals and Systems-principles and applications", Cambridge University press.

E3. NPTEL Course "Principles of Signals & System"
https://nptel.ac.in/courses/108/104/108104100/

E4. Lecture Series on, "Signals & Systems"
http://www.nptelvideos.in/2012/12/signals-and-system.html

E5. ocw.mit.edu

1.7 Teaching Plan and CO Mapped

Unit	Topics to be covered	Book Referred	Total Lecture Planned	CO Mapped	PI Mapped
1	Introduction to Signals & Systems	T1, R3, E1	10	**1, 2**	1.1.1 -2 2.1.3-2
2	Time domain representation of LTI System	T1, R3, E1	8	**2, 3**	1.1.1 -2 1.4.1 - 2 2.1.3-2
3	Fourier Series	T1, R3, E1	7	**4**	1.1.1 -2 1.1.2 - 1 1.4.1 -2 2.1.3 – 2 2.4.1 - 2
4	Fourier Transform	T1, R3, E1	7	**4**	
5	Laplace Transform	T1, R3, E1	8	**4**	

6	Probability and Random Variables	R2, E2	7	**5**	1.1.1 – 2 2.1.3 – 2 2.4.1 - 2

1.8 Unit wise Lecture Plan

1.8 a. Unit No.-I

Introduction to Signals and Systems

Pre-requisites:- Basics of mathematics

Objectives: - 1. To Elaborate the Classification and different operations on signals.

2. To Describe the classification of Systems based on their input-output Relations.

3. Introduce elementary signals and their applications.

Outcomes: - at the end of the unit, students will be able to:

1. Perform the classification and different operations on signals.

2. Categorize the Systems based on their Input-output relations

3. Define the elementary signals in Continuous and Discrete time domain.

Lect. No.	Details of the Topic to be covered	References	CO Mapped	PI Mapped
1.	Definition of signals and systems, communication and control systems as examples	T1, R3, E1	CO1	1.1.1 -2 2.1.3-2
2.	Sampling of analog signals, sampling theorem, Continuous time and Discrete time signal	T1, R3, E1		
3.	Classification of signals as even, odd, periodic and non periodic	T1, R3, E1		
4.	Energy and power signals	T1, R3, E1		

5.	**Elementary signals used for testing:** reasons for using standard test signals, exponential, sine, ramp, rectangular, triangular, signum, sinc.	T1, R3, E1		
6.	Impulse, step and its properties,	T1, R3, E1		
7.	**Systems:** Definition, Classification: linear and non linear, time variant and invariant	T1, R3, E1	CO2	1.1.1 -2 2.1.3-2
8.	Causality, inevitability	T1, R3, E1		
9.	Stability	T1, R3, E1		
10.	System classification	T1, R3, E1		

Question Bank Theory

Tutorial 1

CO Mapped – CO1

A. 1) Sketch and write mathematical expression for the following signals in CT and DT

a) Sine
b) Rectangular
c) Triangular
d) Exponential
e) Unit Impulse
f) Unit Step
g) Ramp
h) Signum
i) Sinc

2) Classify and find the respective value for the above signals

a) Periodic / Non Periodic
b) Energy / Power /Neither

B. Find out if the following signals are Power signals or Energy signals:

1. $x(t)=u(t)=\quad 1, \quad t>0$

= 0, t<0

2. x(t)=δ(t)
3. x(t)=t
4. x(t)=sin(ωt)
5. x(t)=cos(ωt)
6. x(t)=Ae^(at)
7. rect(t)= A, -T≤t≤T
   = 0, ,Otherwise
8. x(t)=e^(-2t)u(t)
9. x(t)=e^(j2t+∏/4)
10. x(t)=cos(t)
11. x[n]=(1/2)^(n) u[n]

C. Find out if the signal is Periodic or Non periodic:

1. x(t)=je^(10t)
2. x(t)=e^(-1+j)t
3. x[n]=e^(j7∏n)
4. x[n]=3e^([3∏(n+1/2)/5]
5. x[n]=e^[j(3n/5 + 3/10)]
6. x[n]=u[n]+u[-n]
7. x(t)=3cos(4t+∏/3)
8. x(t)=e^[j(∏t-1)]
9. x(t)=cos^(2) (2t-∏/3)
10. x(t)=7cos[3∏t/8]+8sin[5∏t/16]

Tutorial 2

CO Mapped – CO1

A. **Take any CT and DT signals and perform the following operation Amplitude scaling, addition, multiplication, differentiation, integration (accumulator for DT), time scaling, time shifting and folding.**

Q. 1 **Sketch the waveforms**

(a) $x(t) = u(t) - u(t-2)$

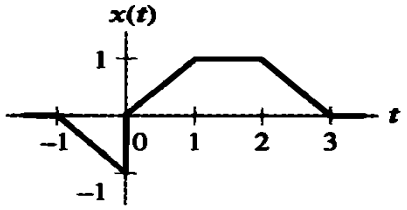
(b) $x(t) = u(t+1) - 2u(t) + u(t-1)$

(c) $x(t) = -u(t+3) + 2u(t+1) - 2u(t-1) + u(t-3)$

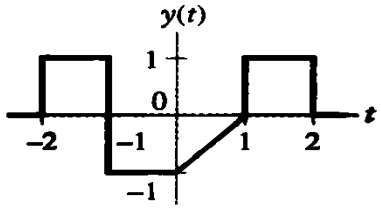
(d) $y(t) = r(t+1) - r(t) + r(t-2)$

(e) $y(t) = r(t+2) - r(t+1) - r(t-1) + r(t-2)$

Q.2 **Follow the precedence rule and sketch for the following**



(a)



(b)

(a) $x(t)y(t-1)$

(b) $x(t-1)y(-t)$

(c) $x(t+1)y(t-2)$

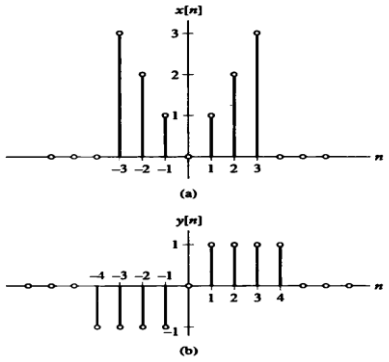
(d) $x(t)y(-1-t)$

(e) $x(t)y(2-t)$

(f) $x(2t)y\left(\frac{1}{2}t+1\right)$

(g) $x(4-t)y(t)$

Q.3 **Follow the precedence rule and sketch for the following**



(a) $x[2n]$
(b) $x[3n-1]$
(c) $y[1-n]$
(d) $y[2-2n]$
(e) $x[n-2]+y[n+2]$
(f) $x[2n]+y[n-4]$
(g) $x[n+2]y[n-2]$
(h) $x[3-n]y[n]$
(i) $x[-n]y[-n]$
(j) $x[n]y[-2-n]$
(k) $x[n+2]y[6-n]$

Tutorial 3

CO Mapped – CO2

Express system mathematical expressions in input output relation form and determine whether each one of them is, Memory less, Causal, Linear, Stable, Time invariant, Invertible.

1. y(t)=t x(t)
2. y(t)=x^2.t
3. y(t)=x(t-2)+x(2-t)
4. y(t)=[cos(3t)].x(t)
5. y(t)= $\int_{-\infty}^{2t} t\,x(t)dt$
6. y(t) =0 , t<0

=x(t)+x(t-2), $t \geq 0$

7.y(t) =0 , $x(t)<0$

=x(t)+x(t-2) , $x(t) \geq 0$

8. y(t)=x(t/3)

9. y(t)=d/dt [x(t)]

10. y[n]=x[-n]

11. y[n]=x[n-2]-2x[n-8]

12. y[n]=n x[n]

13. y[n]=x[n] , $n \geq 1$

=0 , n=0

=x[n+1] , $n \leq -1$

14. y[n]=x[n] , $n \geq 1$

=0 , n=0

=x[n] , $n \leq -1$

15. y[n]=n[4n+1]

Question Bank: Multiple Choice Questions (MCQs)

CO Mapped – CO1, CO2

- Determine whether the following signals are periodic. If they are, find fundamental time period.

1. $x(t) = [\cos(2\pi t)]^2$

   a. 1 b. ½ c. 2 d. Aperiodic

2. $x(t) = 2e^{j(2t + \pi/4)}$

   a. $\pi/2$ b. $\pi/4$ c. π d. Aperiodic

3. $x[n] = \sin[(7\pi/3)n + (2\pi/3)]$

   a. 7 b. 6 c. 5 d. Aperiodic

4. $x(t) = 5\cos(\pi t) + \sin(5\pi t)$

   a. 2 b. 1/2 c. 2/5 d. Aperiodic

- Determine whether the following signals are Energy/Power. Find the value.

5. $x[n] = (1/2)^n u[n]$

   a. Energy, 3/4 b. Power, 4/3 c. Energy, 4/3 d. Zero Signal

6. $x(t) = 2 , -1 \le t \le 1$

   $= 0 , otherwise$

   a. Energy, 6 b. Power, 4 c. Energy, 8 d. Energy, 2

7. $x(t) = t\, u(t)$

   a. Power, ½ b. Energy, ½ c. Power, 1 d. Neither Energy nor Power

8. $x(t) = 1, 0 \le t \le 1$

   $= -1, 1 \le t \le 2$

   a. Energy, 2 b. Energy, 4 c. Power, 2 d. Power, 4

9. Determine even and odd parts of the given signal.

   $x(t) = 1 + t\cos(t) + t^2 \sin(t) + t^3 \sin(t)\cos(t)$

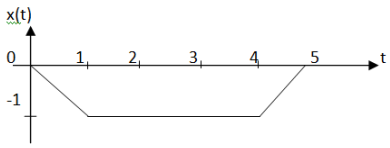
   a. *Even:* $1 + t^3 \sin(t)\cos(t)$
      Odd: $t\cos(t) + t^2 \sin(t)$

   b. *Even:* $t\cos(t) + t^2 \sin(t)$
      Odd: $1 + t^3 \sin(t)\cos(t)$

   c. *Even:* $t\cos(t) - t^2 \sin(t)$
      Odd: $1 - t^3 \sin(t)\cos(t)$

   d. *Even:* $- t\cos(t) - t^2 \sin(t)$
      Odd: $- 1 - t^3 \sin(t)\cos(t)$

10. Write down the equation for the signal x(t) shown in the figure.



   a. $y(t) = -r(t) + r(t-1) + r(t-4) + r(t-5)$

   b. $y(t) = - r(t) + r(t-1) + r(t-4) - r(t-5)$

   c. $y(t) = r(t) - r(t-1) + r(t-4) + r(t-5)$

   d. $y(t) = r(t) + r(t-1) + r(t-4) + r(t-5)$

- Test the following systems for Memory (M/WM), Time Invariance (TI/TV), Linearity (L/NL), Causality (C/NC), Stability (S/US)

11. $y(t) = 2\cos[x(t)]$

    a. WM, TI, L, C, US
    b. WM, TI, NL, NC, US
    c. M, TV, NL, C, US
    d. WM, TI, L, C, S

12. $y(t) = d/dt\{e^{-t} x(t)\}$

    a. WM, TV, L, C, US
    b. WM, TI, NL, NC, US
    c. M, TV, NL, NC, S
    d. WM, TI, L, C, S

13. $y(t) = x(t^3/3)$

    a. WM, TI, L, NC, US
    b. M, TV, NL, C, US
    c. M, TV, L, NC, S
    d. WM, TI, NL, C, S

14. $y[n] = 2x[2^n]$

    a. M, TV, L, NC, US
    b. WM, TI, NL, NC, S
    c. WM, TV, NL, NC, US
    d. M, TV, L, NC, S

15. $y[n] = x^2[n^2 - 1]$

    a. M, TV, L, NC, US
    b. M, TV, NL, NC, S
    c. WM, TV, NL, NC, S
    d. M, TV, L, NC, S

16. Given, $x[n] = \{-1, -1, \underline{0}, 1, 1\}$. Determine – $x[2n+3]$

    a. $\{1, \underline{-1}, 1\}$
    b. $\{-1, 1, \underline{0}\}$
    c. $\{1, \underline{-1}, 0\}$
    d. $\{\underline{0}, -1, 1,\}$

17. Given, $x[n] = \{1, 1, \underline{1}, 1, 1\}$. Determine – $x[3n-2]$

    a. $\{\underline{1}, 1\}$
    b. $\{1, \underline{-1}\}$
    c. $\{1, \underline{1}\}$
    d. $\{-1, \underline{-1}\}$

18 The system $y(t) = x(t) + 2x(t + 3)$ is

a. causal system
b. non-causal system
c. partly (a) and partly (b)
d. none of these

19 The system $y(t) = x(t) + \frac{1}{3}x(t-1)$ is

a. causal system
b. non-causal system
c. partly (a) and partly (b)
d. none of these

20 The system $\frac{dy(t)}{dt} + t^2 y(t) = 2x(t)$ is

a. time invariant system
b. time-variant system
c. partly (a) and partly (b)
d. none of these

21 The system $\frac{dy(t)}{dt} + 3y(t) = x(t)$ is a

a. time invariant system
b. time-variant system
c. partly (a) and partly (b)
d. none of these

HOT* (Higher Order Thinking) Questions

CO Mapped – CO1,CO2

22. Y_1 : It is not mandatory for every signal to be even or odd

Y_2 : : Any signal which is neither even nor odd can be expressed as the difference of even and odd signals

a. Y_1 only

b. Y_2 only

c. Both Y_1 & Y_2 are correct but Y_2 is not a reason for Y_1

d. Both Y_1 & Y_2 are correct but Y_2 is definitely a reason of Y_1

2. **What is the obligatory sequence that need to be performed or executed in time shiftin, scaling and time reversal operational processes under the category of continuous time signals?**

a. Time Shifting, Time Scaling & Time Reversal

b. Time Scaling, Time Reversal & Time Shifting

c. Time Shifting, Time Reversal & Time Scaling

d. Time Reversal, Time Scaling & Time Shifting

3. **The signal energy of the continuous-time signal**

$$x(t)=[(t-1)u(t-1)]-[(t-2)u(t-2)]-[(t-3)u(t-3)]+[(t-4)u(t-4)]$$

is

a. 11/3
b. 7/3
c. 1/3
d. 5/3

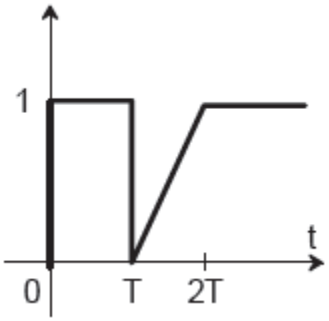
1. **Consider a continuous-time system with input $x(t)$ and output $y(t)$ given by**

$$y(t)=x(t)\cos(t)$$

This system is

a. linear and time-invariant
b. non-linear and time-invariant
c. linear and time-varying
d. non-linear and time-varying

2. **The function shown in the figure can be represented as**



a. $u(t)-u(t-T)+(t-T)Tu(t-T)-(t-2T)Tu(t-2T)$
b. $u(t)+tTu(t-T)-tTu(t-2T)$
c. $u(t)-u(t-T)+(t-T)Tu(t)-(t-2T)Tu(t)$
d. $u(t)+(t-T)Tu(t-T)-2(t-2T)Tu(t-2T)$

1.8 a. Unit No.-II

Time Domain Representation of LTI System

Pre-requisites:- Basics of integration and summation

Objectives:- 1.To Introduce the concept of Impulse response.

2.Analyze and classify the Linear Time Invariant system with the help of convolution Integral and Sum.

Outcomes:- at the end of the unit, students will be able to:

1. Develop input output relationship for linear shift invariant system using convolution.

2. Determine Step response of the system using given Impulse response

Lecture No.	Details of the Topic to be covered	References	CO Mapped	PI Mapped

1.	System modeling: Input-output relation, Definition of impulse response	T1, R3, E1	CO3	1.1.1 -2 1.4.1 - 2 2.1.3-2
2.	Necessity of convolution and convolution sum	T1, R3, E1		
3.	unit step to rectangular and rectangular to rectangular and few more problems	T1, R3, E1		
4.	Computation of convolution sum	T1, R3, E1		
5.	Properties of convolution	T1, R3, E1		
6.	system interconnection and problems	T1, R3, E1		
7.	system properties in terms of impulse response and problems	T1, R3, E1		
8.	step response in terms of impulse response	T1, R3, E1		

Question Bank Theory

Tutorial 4

CO Mapped – CO3

A. Express any two system mathematical expressions in impulse response form and determine whether each one of them is, Memory less, Causal, Linear, Stable, Time in variant, Invertible.

1. h[n]=[1/5]^n .u[n]
2. h[n]=(0.8)^n .u[n+2]
3. h[n]=[1/n]^n .u[-n]
4. h[n]=5^n.u[3-n]
5. h[n]=[-1/2]^n.u[n]+(1.01)^n. u[1-n]
6. h[n]=n[1/3]^n.u[n-1]
7. h(t)=e^(-4t).u(t-2)
8. h(t)=e^(-6t).u[3-t]
10. h(t)=e^(-2t).u(t+50)
11. h(t)=e^(2t).u(-1-t)
12. h(t)=e^(6|t|)
13. h(t)=t.e^(-t).u(t)

14. h(t)=[2e^(-t)-e(t-100)/100].u(t)
15. h(t)=cos(∏t)
16. h(t)=e^(-2t).u(t-1)
17. h(t)=3δ(t)
18. h(t)=cos(∏t).u(t)
19. h[n}=(-1)^n.u[-n]
20. h[n]=(1/n)^|n|
21. h[n]=cos(∏n/8){u[n]-u[n-10]}
22. h[n]=2.u[n]-2u[n-5]
23. h[n]=sin[∏n/2]

B. Evaluate step response of the given LTI system:

1. h[n]=(-1/2)^n.u[n]
2. h[n]=δ[n]-δ[n-2]
3. h[n]=(-1)^n{u[n+2]-u[n-3]}
4. h[n]=n.u[n]
5. h(t)=e^(-|t|)
6. h(t)=δ^2(t)
7. h(t)=(1/4)(u(t)-u(t-4))
8. h(t)=u(t)

Tutorial 5

CO Mapped – CO3

A. Perform Convolution Integral of Two Continuous time Signals.

1. x(t)=u(t), h(t)=u(t)
2. x(t)=u(t), h(t)=e^(-at).u(t)
3. x(t)=e^(-at).u(t), h(t)=e^(-bt).u(t)
4. x(t)=u(t)-u(t-2), h(t)=u(t)

5. x(t)=u(t)-u(t-2), h(t)=e^(-2t).u(t)

6. x(t)=u(t)-u(t-2), h(t)=u(t)-u(t-3)

7. x(t)=[u(t)-u(t-2)].e^(-2t), h(t)=e^(-t).u(t)

8. x(t)=u(t)-u(t-2), h(t)=u(t)-u(t-2)

B.

Q. 1 **Evaluate**

(a) $y[n] = u[n+3] * u[n-3]$

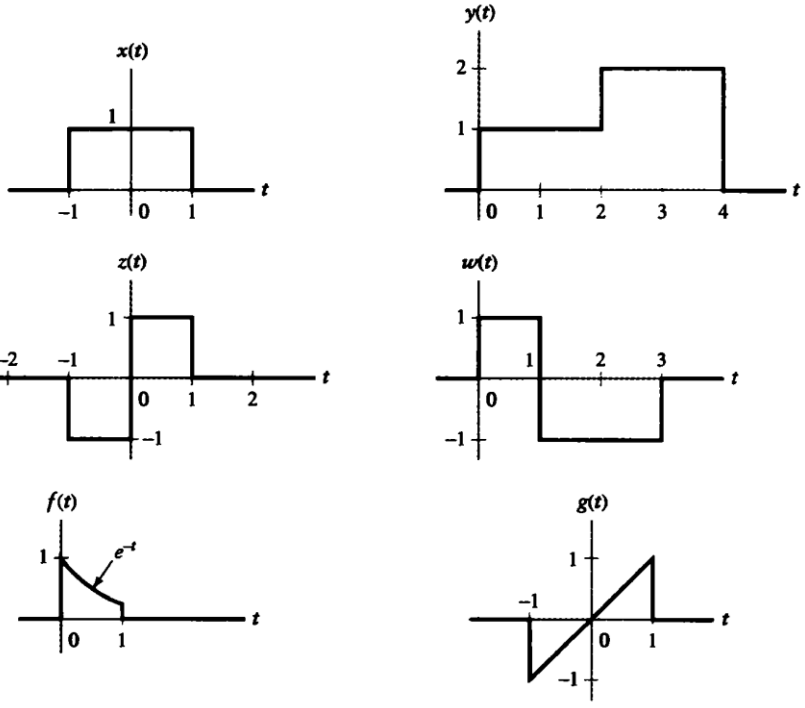
(b) $y[n] = 3^n u[-n+3] * u[n-2]$

(c) $y[n] = \left(\frac{1}{4}\right)^n u[n] * u[n+2]$

(d) $y[n] = \cos\left(\frac{\pi}{2}n\right)u[n] * u[n-1]$

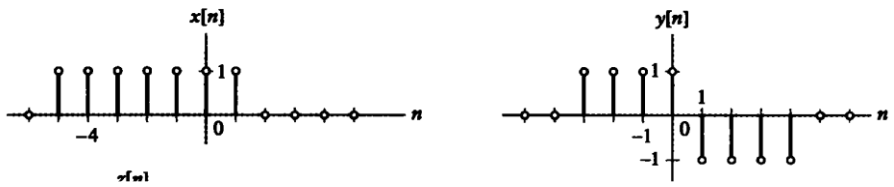
(e) $y[n] = (-1)^n * 2^n u[-n+2]$

Q.2 **Given -**



Evaluate-

	i. $m(t) = x(t) * y(t)$ *ii.* $m(t) = x(t) * z(t)$ *iii.* $m(t) = x(t) * w(t)$ *iv.* $m(t) = x(t) * f(t)$ *v.* $m(t) = x(t) * g(t)$ *vi.* $m(t) = z(t) * y(t)$ *vii.* $m(t) = g(t) * y(t)$ *viii.* $m(t) = w(t) * y(t)$ *ix.* $m(t) = f(t) * y(t)$ *x.* $m(t) = g(t) * f(t)$

Q.3	**Given –**  **Evaluate –** $m[n] = x[n] * y[n]$

Question Bank: Multiple Choice Questions (MCQs)

CO Mapped – CO3

Test for Causality and Stability of the Impulse response given below.

1. $h[n] = (1/5)^n u[n]$

a. NC, US

b. C, US

c. NC, S

d. C, S

2. $h[n] = (0.8)^n u[n+2]$

a. NC, US

b. C, US

c. NC, S

d. C, S

3. $h(t) = e^{2t}\, u(-t-1)$

a. NC, US

b. C, US

c. NC, S

c. C, S

4. $h(t) = e^{-6t}\, u(3-t)$

a. NC, US

b. C, US

c. NC, S

c. C, S

5. Evaluate - $u(t) * u(t)$

a. t

b. $t\, u(-t)$

c. $-t\, u(-t)$

d. $t\, u(t)$

6. Evaluate - $u(t) * [\, e^{-at}\, u(t)]$

a. $a\,(1-e^{at})\, u(t)$

b. $1/a\,(1-e^{at})\, u(t)$

c. $1/a\,(1-e^{-at})\, u(t)$

d. $a\,(1-e^{-at})\, u(t)$

7. Evaluate - $[\, e^{-2t}\, u(t)] * [\, e^{-3t}\, u(t)]$

a. $(e^{-3t} - e^{-2t})/5$

b. $(e^{-3t} - e^{-2t})$

c. $(e^{-2t} - e^{-3t})$

d. $(-e^{-3t} + e^{-2t})/5$

8. Evaluate - $u(t) * [\, u(t) - u(t-2)\,]$

a. $y(t) = t\,; \quad 0 \le t \le 2$

$= 2; \quad t > 2$

b. $y(t) = 2\, u(t-2)$

c. $y(t) = t-2\,; \quad 0 \le t \le 2$

$= 2; \quad t > 4$

d. $y(t) = t\, u(t)$

9. Evaluate - $[\, u(t) - u(t-2)\,] * [\, u(t) - u(t-2)\,]$

10. Evaluate convolution – $x[n] = \{1, \underline{2}, 3, 4\}$ **and** $y[n] = \{4, 3, \underline{2}, 1\}$

a. {4, 11, <u>20</u>, 30, 25, 8, 4}

b. {4, 8, <u>25</u>, 30, 20, 11, 4}

c. {<u>4</u>, 11, 20, 30, 20, 11, 4}

d. {4, 11, 20, <u>30</u>, 20, 11, 4}

11. Evaluate convolution – $x[n] = \{\underline{1}, 2, 1, 2\}$ **and** $y[n] = \{\underline{2}, 1, 2, 1\}$

a. {2, <u>5</u>, 6, 10, 6, 5, 2}

b. {<u>2</u>, 5, 6, 10, 6, 5, 2}

c. {2, 5, 6, 10, 6, <u>5</u>, 2}

d. {2, 5, 6, <u>10</u>, 6, 5, 2}

12. Evaluate convolution – $x[n] = \{\underline{2}, 1, 1, 1\}$ **and** $y[n] = \{2, \underline{1}, 1, 1\}$

a. {4, <u>4</u>, 5, 6, 3, 2, 1}

b. {4, 4, 5, <u>6</u>, 3, 2, 1}

c. {4, 4, 5, 6, 4, <u>4</u>, 5}

d. {4, <u>5</u>, 4, 6, 5, 2, 1}

13. Determine step response from the Impulse Response given –> h(t) = $\delta(t) - \delta(t-2)$

a. $u(t) - u(t-2)$

b. ∞

c. $- u(t) - u(t-2)$

d. 0

14. Determine step response from the Impulse Response given –> h(t) = $e^{-|t|}$

a. 2

b. $(2 - e^{-t})\, u(t)$

c. $2\,(1 - e^{-t})\, u(t)$

d. $(2 - e^{-t})$

15. Mark the correct statement

a. $x(t) * \delta(t - t_0) = x(t_0)$

b. $x(t) * \delta(t - t_0) = x(t - t_0)$

c. $x(t) * \delta(t - t_0) = 1$

d. $x(t) * \delta(t - t_0) = x(t + t_0)$

16. Mark the wrong statement

a. $x(t) * \delta(t) = x(t)$

b. $x(t) * \delta(t - t0) = x(t - t0)$

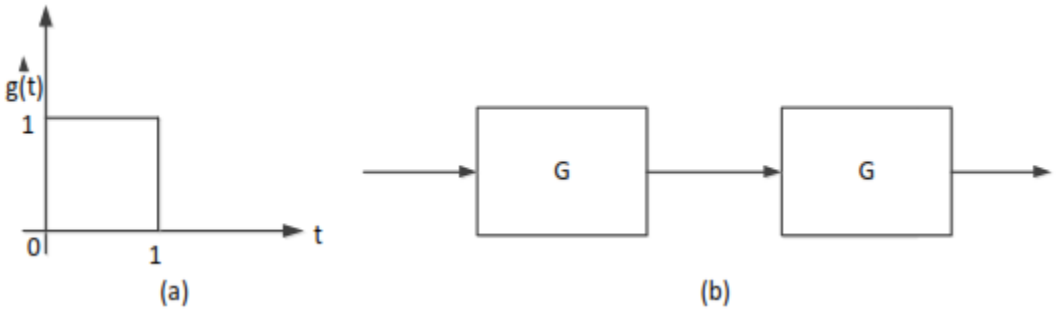
c. $x(t - t_{01}) * \delta(t - t_{02}) = x(t - t_{01} - t_{02})$

d. $\delta(t - t_{01}) * \delta(t - t_{02}) = \delta(t_{01} - t_{02})$

HOT* (Higher Order Thinking) Questions

CO Mapped – CO3

1. The impulse response g(t) of a system, *G*, is as shown in Figure (a). What is the maximum value attained by the impulse response of two cascaded blocks of *G* as shown in Figure(b)?



a. 23

b. 34

c. 45

d. 1

2. Consider an LTI system with impulse response $h(t)=e^{-5t}u(t)$.

If the output of the system is $y(t)=e^{-3t}u(t)-e^{-5t}u(t)$.

then the input, $x(t)$, is given by

a. $e^{-3t}u(t)$

b. $2e^{-3t}u(t)$

c. $e^{-5t}u(t)$

d. $2e^{-5t}u(t)$

3. The impulse response of a system is *h(t) = t u(t)* . For an input *u(t -1)* , the output is

a. $t^2/2\ u(t)$

b. $t(t-1)/2\ u(t-1)$

c. $t(t-1)/2\ u(t-1)$

d. $(t^2-1)/2\ u(t-1)$

1.8 a. Unit No.-III

Fourier Series

Pre-requisites:- Convolution, properties of signals and systems, Integration and Summation Operation

Objectives:-

1. To Introduce CT and DT systems in the Time & Frequency domain using Analysis tools
2. To represent the signals in terms of its Fourier coefficients and analyze them using CT and DT Fourier Series.
3. To Understand and apply the Dirichlet's conditions to obtain the Fourier series.

Outcomes:-

1. Describe and analyze signals in the Time & frequency domain using Fourier series.
2. Determine Amplitude and Frequency spectrum using Fourier series

Lecture No.	Details of the Topic to be covered	References	CO Mapped	PI Mapped
1	Fourier series (FS) representation of periodic CT signals	T1, R3, E1	CO4	1.1.1 -2 1.1.2 - 1 1.4.1 -2 2.1.3 – 2 2.4.1 - 2
2	Dirichlet's condition for existence of Fourier series, orthogonality, basis functions	T1, R3, E1		
3	amplitude and phase response, FS representation of CT signals using trigonometric Fourier series.	T1, R3, E1		
4	Exponential Fourier series.	T1, R3, E1		
5	Applications of Fourier series, properties of Fourier series and their physical significance	T1, R3, E1		
6	Gibbs phenomenon, Discrete Time Fourier Series	T1, R3, E1		
7	Discrete Time Fourier Series properties convergence of DTFS	T1, R3, E1		

Question Bank Theory

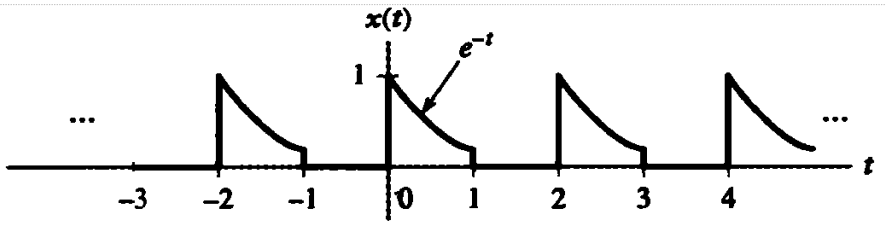
Tutorial 6

CO Mapped – CO4

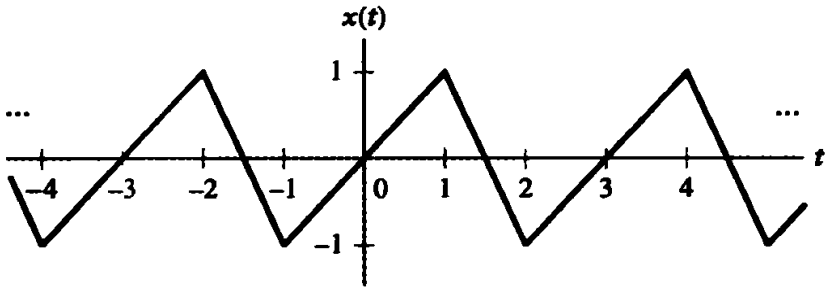
- **Find EFS and TFS expansion for the following signals**

Q. 1	Half wave rectified signal
Q.2	Full wave rectified signal
Q.3	Saw tooth wave
Q. 4	**Triangular wave**
Q. 5	**Square wave**

Q. 6



Q.7



Question Bank: Multiple Choice Questions (MCQs)

CO Mapped – CO4

1. Determine Exponential Fourier Series Coefficients of – *x(t) = cos ωt*

a. -½, -½ b. ½, ½

c. ½, -½ d. -½, ½

2. Determine Exponential Fourier Series Coefficients of – *x(t) = cos 4t + sin 6t*

a. *1/2j, ½, ½, 1/2j* b. *-1/2j, ½, ½, -1/2j*

c. *1/2j, -½, -½, 1/2j* d. *-1/2j, ½, ½, 1/2j*

3. Duality property is -

a. $X(t) \leftrightarrow 2\pi\, x(-\omega)$ b. $x(at) \leftrightarrow (1/|a|)\, X(\omega/a)$

c. $x(-t) \leftrightarrow X(-\omega)$ d. $(-jt)\, x(t) \leftrightarrow d[x(-\omega)]/d\omega$

4. Fourier Series of any signal *x(t) can only be obtained if* -

a. $\int_0^t |x(t)|dt < \infty$ b. Finite number of discontinuities within finite interval T

c. both a and b c. infinite no. of discontinuities

5. Magnitude spectrum |*X(ω)*| is an -

a. even function b. odd function

c. Neither even nor odd d. even and odd both

6. Phase spectrum of $X(\omega)$ is an -

a. even function b. odd function

c. Neither even nor odd d. even and odd both

7. *F.T. of x(t) = sgn(t) is -*

a. $(2/j\omega) + \pi\,\delta(\omega)$ b. $2/j\omega$

c. $-2/j\omega$ d. $1/j\omega$

8. *F.T. of 1 is -*

a. $\pi\,\delta(\omega)$ b. $(\pi/2)\,\delta(\omega)$

c. $2\pi\,\delta(\omega)$ d. $2\pi\,\delta(-\omega)$

9. *If $X(\omega) = \delta(\omega - \omega_0)$ the x(t) is -*

a. $e^{-j\omega 0t}$ b. $\delta(t)$

c. $(1/2\pi)\,e^{j\omega 0t}$ d. 1

10. Expression for *DTFT* is -

a. $\sum_{n=-\infty}^{n=\infty} x[n]\,e^{j\omega_0 n}$ *b.* $\sum_{n=-\infty}^{n=\infty} x[n]$

c. $\sum_{n=-\infty}^{n=\infty} x[n]\,e^{-j\omega_0 n}$ *d.* $\sum_{n=-\infty}^{n=\infty} e^{-j\omega_0 n}$

11. *F.T. of u(t) is -*

a. $(1/j\omega)$ b. $(-1/j\omega) - \pi\,\delta(\omega)$

c. $(1/j\omega) + 2\pi\,\delta(\omega)$ d. $(1/j\omega) + \pi\,\delta(\omega)$

12. *$x(t) = \cos(\pi t)$ has following FS coefficients*

a. a_0, a_k, b_k b. b_k only

c. a_0, a_k d. a_k only

13. *F.T. of $e^{-|t|}$ is -*

a. $2/(1 + \omega^2)$ b. $2/(1 - \omega^2)$

c. $1/(1 + \omega^2)$ d. $1/(1 - \omega^2)$

14. Match the following pairs.

1. $e^{-j\omega_0 t}$	I. a constant
2. $\frac{\sin(n\omega)}{\omega}$	II. '*t*' multiplied with exponential function
3. $k\,\delta(\omega)$	III. Rectangular Pulse

4. $\frac{1}{(3+j\omega)^2}$ IV. Shifted Impulse function

a. 1-IV, 2-III, 3-II, 4-I b. 1-I, 2-II, 3-III, 4-IV

c. 1-IV, 2-III, 3-I, 4-II d. 1-I, 2-II, 3-IV, 4-III

1.8 a. Unit No.-IV

Fourier Transform

Pre-requisites:- Fourier series

Objectives:-

1. To understand the Properties of Fourier Transform.
2. To analyze signals using CT and DT Fourier Transform.

Outcomes:-

1. Describe and analyze signals in the Time & Transform domain using Fourier Transform.
2. Determine Magnitude and Phase response using Fourier Transform.

Lecture No.	Details of the Topic to be covered	References	CO Mapped	PI Mapped
1	Fourier Transform (FT) representation of aperiodic CT signals	T1, R3, E1	CO4	1.1.1 -2 1.1.2 - 1 1.4.1 -2 2.1.3 – 2 2.4.1 - 2
2	Dirichlet condition for existence of Fourier transform, evaluation of magnitude and phase response	T1, R3, E1		
3	FT of standard CT signals, FT of standard periodic CT signals	T1, R3, E1		
4	Properties and their significance	T1, R3, E1		
5	Interplay between time and frequency domain using sinc and rectangular signals	T1, R3, E1		

6	Fourier Transform for periodic signals	T1, R3, E1		
7	Introduction to Discrete Time Fourier Transform	T1, R3, E1		

Question Bank Theory

Tutorial 7

CO Mapped – CO4

A. **State and prove the various properties of CT Fourier Transform. Take rectangular and sinc Signal as examples and demonstrate the applications of CTFT properties. And also demonstrate the interplay between the time and frequency domain.**

State and Prove the properties of Fourier transform

a	**Linearity**
b	**Time shifting**
c	**Frequency shifting**
d	**Time scaling**
e	**frequency scaling**
f	**Convolution in time**
g	**Convolution in frequency**
h	**Parseval's theorem**
h	**Differentiation in time**

i	**Differentiation in frequency**
j	**integration in time**

B. Obtain the Fourier transform of Following Signals

Q1) x(t) = rect $(\frac{t}{2T})$ |t|<=T

Q2) x(t) = $\frac{1}{2\pi} \int_{-\infty}^{\infty} X(j\omega)e^{\omega t}\, d\omega$

Q3) x(t) = $\begin{cases} t\ , & |t| \leq 1 \\ 0\ , & |t| \geq 1 \end{cases}$

Q4) x($j\omega$) = $\begin{cases} 2\cos\omega & |\omega| \leq \pi \\ & |\omega| \geq \pi \end{cases}$

Q5) x(t) = $\begin{cases} e^{j\omega t} & |t| \leq \pi \\ 0 & otherwise \end{cases}$

Q6) x(t) = e^{-at} cos ω_0t u(t)

Q7) x(t) = e^{-at} u(t)

Q8) Show that u(t) $\leftrightarrow \frac{1}{j\omega} + \delta(\omega)$

Q9) Show that $\delta(t) \leftrightarrow 1$

Q10) Show that $1 \leftrightarrow 2\pi\, \delta(\omega)$

Q11) State that Sig(t) $\leftrightarrow \frac{2}{j\omega}$

Find-i) |x(jω)| < x(jω)

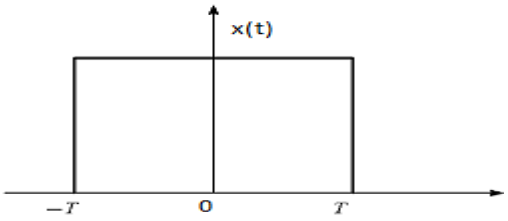
ii) x(jω) = $\int_{-\infty}^{\infty} x(t)\, e^{-j\omega t}\, dt$

Q12) x(jω) = $-\frac{j\omega}{j\omega^2+3j\omega+2}$

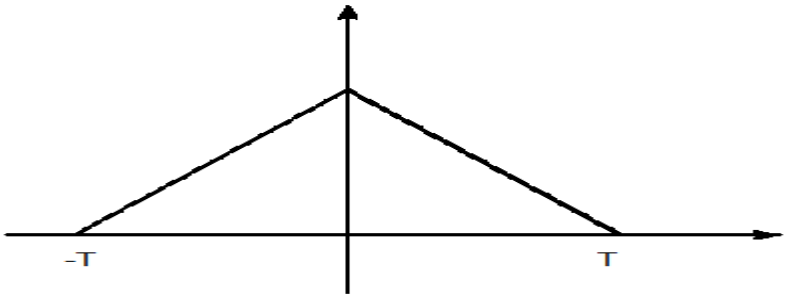
Q13) x(jω) = $\frac{(-j\omega+1)}{(j\omega)^2+5j\omega+6}$

Q14) x(jω) = $\frac{j\omega}{(2+j\omega)^2}$

Q15) Obtain F.T. of Rectangular Pulse



Q16) Obtain F.T. of



Q17) x(jω) = $(j\omega)/(2 + j\omega)^2$

Q18) x(jω) = $\frac{4}{\omega^2}$ $\sin^2\omega$

Q19) x(t) = $\frac{4}{\pi^2 t^2}$ $\sin^2(t^2)$

Q20) Parseval's: x(t) = e^{-2t} u(t)

Q21) x(t) = $2\int_{-\infty}^{\infty} \frac{1}{(2j\omega)^2}\, d\omega$

C. Obtain the Discrete Time Fourier transform of Following Signals

Q1) x(n) = u(n) – u(n-6)

Q2) x(n) = 2^n [u(n) – u(n - 4)

Q3) x(n) = $\left(\frac{1}{2}\right)^n$

Q4) x(n) = $\left(\frac{1}{4}\right)^{n+3} u(n)$

Q5) x(n) = $\left(\frac{1}{2}\right)^n u(n-4)$

Q6) x(n) = $a^n u(-n)$ a > 1

HOT* (Higher Order Thinking) Questions

CO Mapped – CO4

1. Consider a signal defined by

$x(t)=\{e^{j10t}$ for $|t|\leq 1$

$= 0$ for $|t|>1$

Its Fourier Transform is

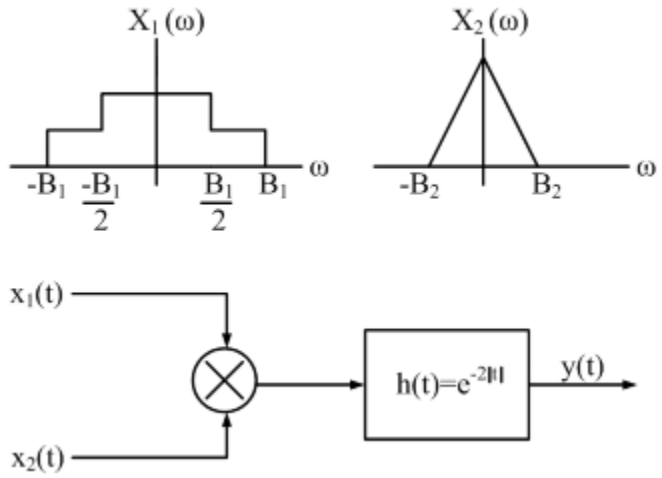
a. $2\sin(\omega-10)/\omega-10$

b. $2e^{j10}\sin(\omega-10)/\omega-10$

c. $2\sin\omega/\omega-10$

d. $e^{j10\omega}\,2\sin\omega/\omega$

2. Let $x_1(t)\leftrightarrow X_1(\omega)$ and $x_2(t)\leftrightarrow X_2(\omega)$ be two signals whose Fourier Transforms are as shown in the figure below. In the figure, $h(t)=e^{-2|t|}$ denotes the impulse response.



For the system shown above, the minimum sampling rate required to sample y(t), so that y(t) can be uniquely reconstructed from its samples, is

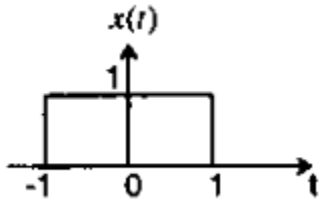
a. $2B_1$

b. $2(B_1+B_2)$

c. $4(B_1+B_2)$

d. ∞

3. ***x(t)*** **is a positive rectangular pulse from t = -1 to t = +1 with unit height as shown in the figure. The value of** $\int_{-\infty}^{\infty}|X(\omega)|^2 d\omega$**, {where** $X(\omega)$ **is the Fourier transform of** $x(t)$**} is:**



a. 2
b. 2π
c. 4
d. 4π

4. The value of the integral $2\int_{\infty}^{-\infty}(sin2\pi t/\pi t)dt$ **is equal to:**

a. 0
b. 0.5
c. 1
d. 2

1.8 a. Unit No.-V

Laplace Transform and its Applications

Pre-requisites:- Signals and Systems – unit 1&2

Objectives:-

1. To understand the need and properties of Laplace Transform.
2. To understand the concept of ROC of Laplace Transform.
3. To Apply Laplace Transform to analyze the systems.

Outcomes:-

1. Describe and analyze signals in the Time & Transform domain using Laplace Transform.

2. Implement the concept and properties of Laplace Transform to analyze and synthesize the systems.

Lecture No.	Details of the Topic to be covered	References	CO Mapped	PI Mapped
1	Definition of Laplace Transform (LT), Limitations of Fourier transform and need of Laplace transform, Region of convergence	T1, R3, E1	CO4	1.1.1 -2 1.1.2 - 1 1.4.1 -2 2.1.3 – 2 2.4.1 - 2
2	Laplace transform of standard periodic and aperiodic functions, properties of Laplace transform and their Significance	T1, R3, E1		
3	Properties of Laplace transform and their significance	T1, R3, E1		
4	Laplace transform evaluation using properties, Inverse Laplace transform based on partial fraction expansion	T1, R3, E1		
5	Stability considerations in S domain, concept of poles and zeros.	T1, R3, E1		
6	Application of Laplace transforms to the LTI system analysis.	T1, R3, E1		
7	Application of Laplace transforms in signal analysis.	T1, R3, E1		
8	Application of Laplace transforms to analyze electrical circuits.	T1, R3, E1		

Question Bank Theory

Tutorial 8

CO Mapped – CO4

A. State and prove the properties of CT Laplace Transform. Take any example of a system in time domain and demonstrate the application of LT in system analysis.

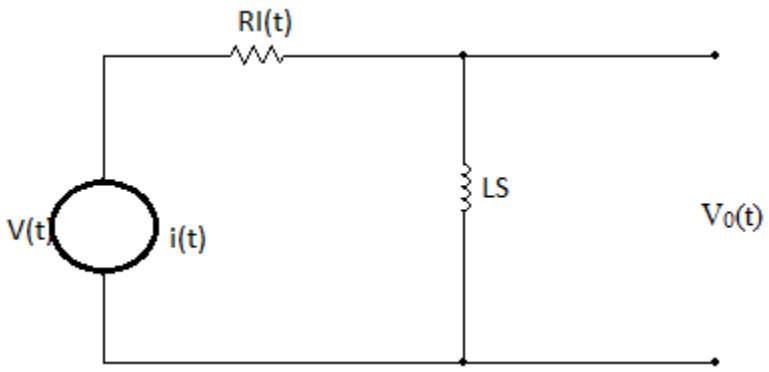
State and Prove the properties of Laplace Transform

a	**Linearity**

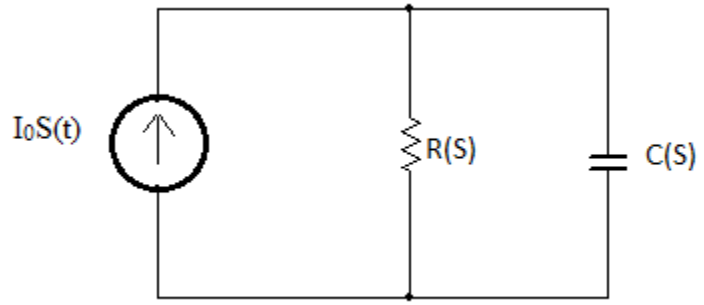
b	**Time shifting**
c	**Frequency shifting**
d	**Time scaling**
e	**frequency scaling**
f	**Convolution in time**
g	**Convolution in frequency**
h	**Parseval's theorem**
i	**Differentiation in time**
j	**Differentiation in frequency**
k	**integration in time**

B. Use Laplace transform to analyze following LTI Systems

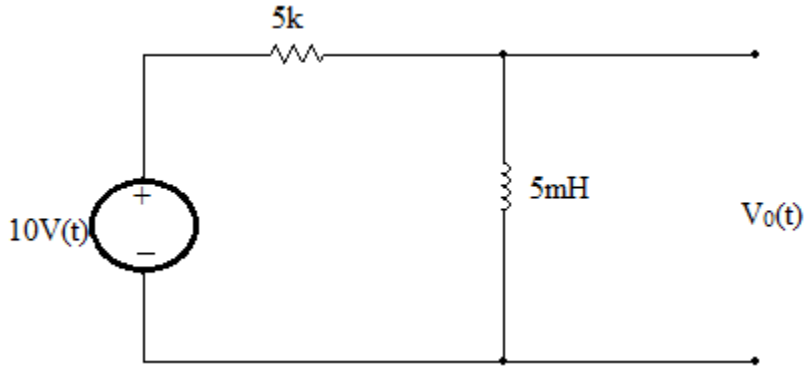
Q1) Find transfer function of current i(t) for the given circuit



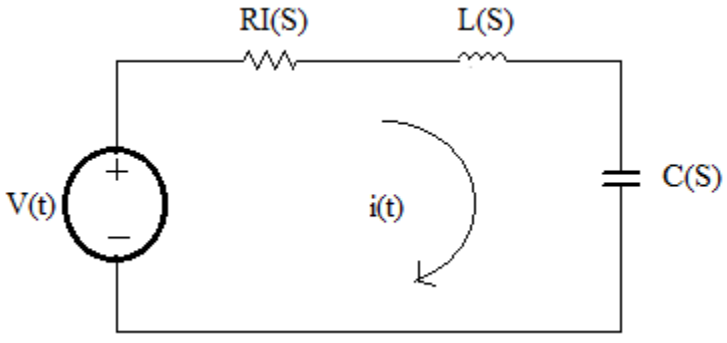
Q2) Find $V_0(t)$. Consider $(0^-) = 0$



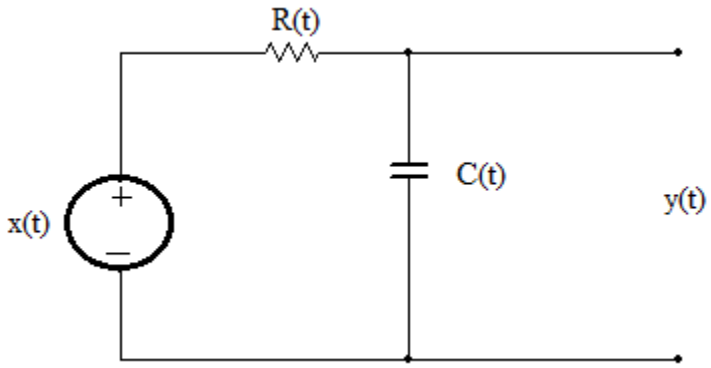
Q3) Find $V_0(t)$, if $i(0^-) = -2mH$



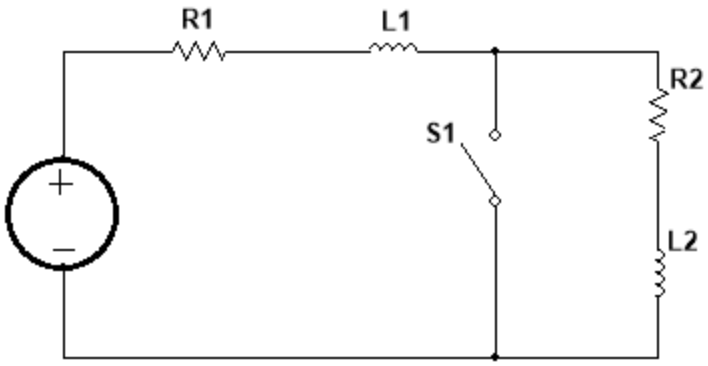
Q4) Obtain H(S)



Q5) $R = 1k\Omega, C = 200\mu F$. Obtain y(t)



Q6) R1 = 10Ω, R2 = 15Ω, L1 = 3H, L2 = 2H. determine y(t).



Question Bank: Multiple Choice Questions (MCQs)

CO Mapped – CO4

1. **Evaluate L.T. of $x(t) = e^{-2t}\,u(t)$**
   a. 1/s+2, σ < -2
   b. 1/s+2, σ > -2
   c. 1/s-2, σ < -2
   d. 1/s+2, σ > 2
2. **Evaluate L.T. of $x(t) = e^{-a|t|}$**
   a. $\frac{-2a}{s^2-a^2}$, σ > -a
   b. $\frac{-2a}{s^2-a^2}$, σ < a
   c. $\frac{-2a}{s^2-a^2}$, -a ≤ σ ≤ a
   d. $\frac{2a}{s^2+a^2}$, -a ≤ σ ≤ a
3. **Find $x(t)$ if $X(s)=\frac{(s+1)}{(s+2)(s+3)}$ for the ROC σ < -3**
   a. $[e^{-2t} - 2e^{-3t}]\,u(t)$
   b. $[e^{-3t} + e^{2t}]\,u(t)$
   c. $[e^{2t} - e^{-3t}]\,u(-t)$
   d. $[e^{-2t} - 2e^{-3t}]\,u(-t)$
4. **Evaluate L.T. of $x(t) = u(t-a)$**
   a. $1/s^2$
   b. e^{at}/s
   c. e^{-as}/s
   d. e^{as}/s
5. **Evaluate L.T. of $x(t) = [e^{-at}\cos 5t\,u(t)]$**

a. $\frac{s-a}{(s-a)^2+25}$ b. $\frac{s+a}{s^2+5}$

c. $\frac{s-a}{s^2-a^2+25}$ d. $\frac{s}{(s-a)^2+5}$

6. Evaluate *I.L.T.* of $X(s) = \frac{6}{s^2+6s+9}$

a. $6\,e^{2t}$ b. $8\,e^{-8t}$

c. $6\,t\,e^{-3t}$ d. $9\,t\,e^{-4t}$

7. Evaluate L.T. of $x(t) = [e^{-t}\,u(t)] * [\cos(t-2)\,u(t-2)]$

a. $X(s) = \frac{e^{-2s}}{(s+1)(s^2+1)}$ b. $X(s) = \frac{se^{-2s}}{(s+1)(s^2+1)}$

c. $X(s) = \frac{e^{-2s}}{(s-1)(s^2-1)}$ d. $X(s) = \frac{e^{2s}}{(s-1)(s^2-1)}$

8. Evaluate initial and Final Value of $X(s) = \frac{(2s+3)}{s^2+5s+6}$

a. $x(0) = 2, x(\infty) = 0$ b. $x(0) = 0, x(\infty) = 2$

c. $x(0) = -3, x(\infty) = 0$ d. $x(0) = 2, x(\infty) = -4$

9. Match the following.

a. T	I. $\omega/(s^2 + \omega^2)$
b. $u(t)$	II. $1/s^2$
c. e^{at}	III. $1/s$
d. $\sin \omega t$	IV. $1/(s-a)$

a. A – II, B – III, C – IV, D – I
b. A – III, B – II, C – IV, D – I
c. A – I, B – II, C – III, D – IV
d. A – IV, B – III, C – II, D – I

10. If $x(t) \leftrightarrow X(s)$,
$t\,x(t) \leftrightarrow$?

a. $-\frac{dX(s)}{ds}$ b. $\frac{dX(s)}{ds}$

c. $s\frac{dX(s)}{ds}$ d. $-s\frac{dX(s)}{ds}$

11. A Laplace Transform exists when _____

A. The function is piece-wise continuous
B. The function is of exponential order
C. The function is piecewise discrete
D. The function is of differential order

a. A & B b. C & D

c. A & D d. B & C

12. Evaluate the L.T. of - $e^{2t}\,X(t)$

a. $x(s+2)$ b. $2\,x(s)$

c. $x(s-2)$ d. $x(s)/2$

13. Region of convergence of *X(s)* contain

a. zeros b. poles

c. no zero d. no pole

HOT* (Higher Order Thinking) Questions

CO Mapped – CO4

1. **The Laplace Transform of**

$$f(t)=e^{2t}\sin(5t)u(t)$$

is

a. $5/s^2-4s+29$
b. $5/s^2+5$
c. $S-2/s^2-4s+29$
d. $5/s+5$

2. The transfer function of a system is $Y(S)/R(S) = S/S+2$. The steady state output $y(t)$ is $A\ cos(2t+\varphi)$ for the input $\cos(2t)$ The values of A and φ respectvely are:

a. $12\sqrt{},-45\circ$
b. $12\sqrt{},+45\circ$
c. $2\sqrt{},-45\circ$
d. $2\sqrt{},+45\circ$

1.8 a. Unit No.-VI

Probability and Random Signals

Pre-requisites:- Probability theory

Objectives:-

1. To use the concept of probability to understand various probability models.
2. To Introduce the concept of Random variable to understand and analyze CDF and PDF.
3. To Introduce the Concept of Correlation of signals.

Outcomes:-

1. Perform Statistical analysis of signals using probability theory
2. Implement the properties of CDF and PDF for system analysis.
3. Use the properties of correlation to design and analyze the systems.

Lecture No.	Details of the Topics to be covered	References	CO Mapped	PI Mapped
1	**Probability:** Experiment, sample space, event, probability	R2, E2	5	1.1.1 – 2 2.1.3 – 2 2.4.1 - 2
2	Conditional probability and statistical independence, Bayes theorem	R2, E2		
3	Uniform and Gaussian probability models.	R2, E2		
4	**Random variables:** Continuous and Discrete random variables, cumulative distributive function, Probability density function	R2, E2		
5	properties of CDF and PDF	R2, E2		
6	Statistical averages, mean, moments and expectations, standard deviation and variance	R2, E2		
7	Probability Distribution models, CDF/PDF and their statistical parameters	R2, E2		

Question Bank Theory

Tutorial 9

CO Mapped – CO5

Q1) Determine the auto correlation function energy spectral density of

$x(t)=\cos \pi t(t+2)$ and sketch the auto correlation.

Q2) Find auto correlation PSD and power of given signal

$x(t)=2 \cos t +3 \cos 3t + 5 \sin 4t$.

Q3) Prove that auto correlation and Energy Spectral Density form a FT pair. Verify the same for the given signal:

$x(t)=e^{-at}$.

Q4) Obtain the cross correlation of following discrete time signal

x[n]={1,2,3,4}

y[n]={3,2,1,0}

using graphical and analytical expression method.

Q5) Find the following for given energy signal $x(t)= e^{-4t} u(t)$.

Find- i) auto correlation

ii) Energy

iii) Energy from definition

iv) ESD using autocorrelation

v) ESD from definition

Q6) For a given power signal $x(t)= 6 \sin(2t)$

Find- i) Auto correlation

ii) Power from autocorrelation

iii) Power from definition

iv) PSD from autocorrelation

v) PSD from definition

Tutorial No. 10

CO Mapped – CO5

Q1) The PDF of RV of 'x' is defined as $f_x(x)=\begin{cases} ke^{-4x}, & x>0 \\ 0, & x\leq 0 \end{cases}$

Find- i) constant k

ii) p(1<x<2)

iii) p(x >= 3)

iv) p(x<1)

Q2) A random variable x is defined by CDF $F_x(x)=\begin{cases} 0, & x<0 \\ \frac{x}{2}, & 0\leq x\leq 1 \\ k, & x\geq 1 \end{cases}$

Find- i) constant k

ii) sketch PDF

iii) P(x>=2)

Q3) PDF of a random variable 'x' is given as $F_x(X)= e^{-x}$ for x>=0

Find-i) Mean f(x)

ii) mean square $f(x^2)$

iii) Variance

iv) Step deviation

Q4) Explain Gaussian probability model w.r.t its density & distribution function. Derive its expression for CDF.

Q5) List and explain the properties of CDF and PDF.

Q6) Explain uniform distribution model and obtain its CDF, means, square value and variance.

Q7) Suppose that a certain RV bias CDF $f_x(x)=\begin{cases} 0, & x\leq 0 \\ kx^2, & 0\leq x\leq 10 \\ 100k, & x>10 \end{cases}$

Find-i) constant k

ii) P(x<=5)

iii) Calculate P(5<=x<=7)

iv) Sketch PDF

Q8) Find mean, second moment and standard deviation of 'x' when

$F_x(x)=Ae^{-A\alpha}u(\alpha)$.

Q9)If the PDF of RV is given by $F_x(x)=(1-x)^2$, 0 <= x <= 1

Then find mean, mean square value, variance, standard Deviation.

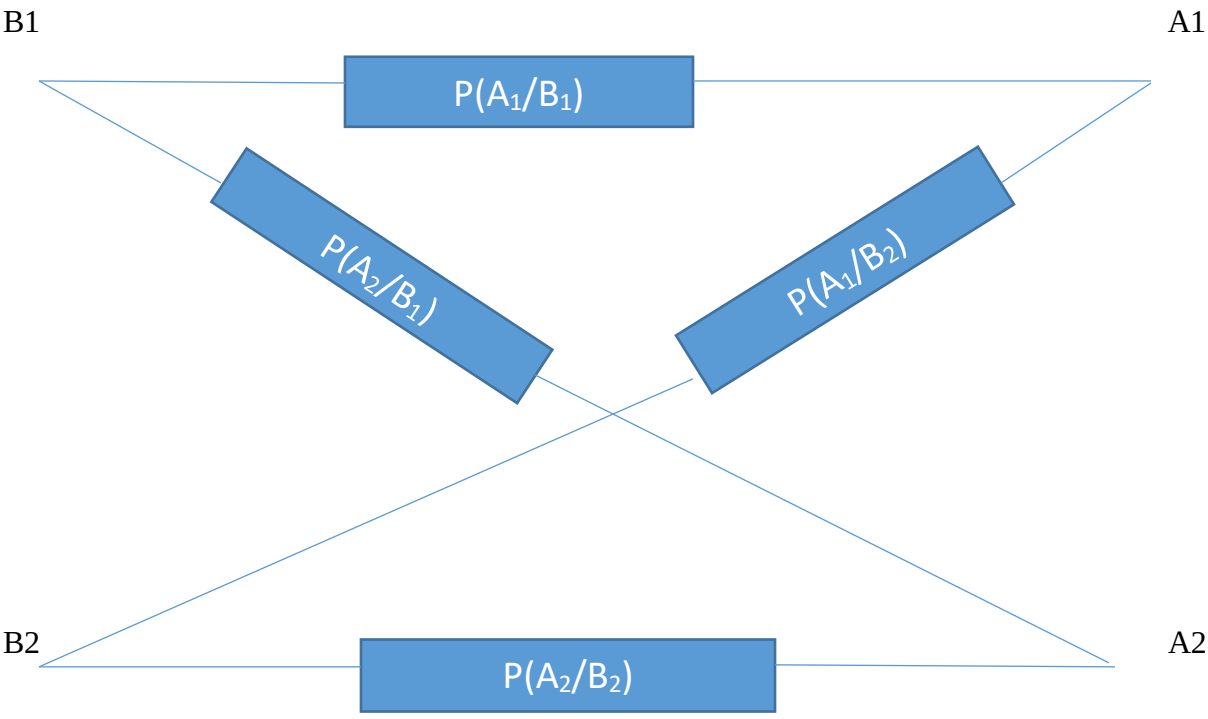
Q10) For the binary symmetric channel obtain probability for

Find-i) Correct Transmission

ii) Transmission with Error

where i) $P(B_1)= 0.6$

ii) $P(B_2)= 0.4$



Question Bank: Multiple Choice Questions (MCQs)

CO Mapped – CO5

1.	Three unbiased coins are tossed, what is the probability of getting at least 2 tails ?	
	a. 1/3	b. 1/6
	c. 1/8	d. 1/2
2.	*In a throw of dice what is the probability of getting number greater than 5?*	
	a. 1/3	b. 1/2
	c. 1/5	d. 1/6
3.	*What is the probability of getting a sum 9 from two throws of dice.*	
	a. 1/3	b. 1/9
	c. 1/12	d. 2/9
4.	A numerical description of the outcome of an experiment is called a - a. descriptive statistic b. probability function c. variance d. random variable	
5.	The probability associated with the reduced sample space is called:	
	a. Conditional probability	b. Statistical probability
	c. mathematical probability	d. Subjective probability
6.	Five cards are selected at random from a pack of 52 cards with replacement The possible combinations are:	
	a. *52*	b. 52^5
	c. *52X52*	d. 5^{52}
7.	If P(B/A)= 0.50 and P(A∩B) = 0.40, then p(A) will be equal to:	
	a. 0.4	b. 0.8
	c. 0.5	d. 1
8.	If P(A/B) = P(A) and P(B/A)=P(B), then A and B are:	
	a. Mutually exclusive	b. Dependent

	c. Equally likely	d. Independent
9.	If A and B are any two events, then P(A'/B) is equal to:	
	a. P(A/B)	
	b. 1-P(A/B)	
	c. 1+P(A/B)	
	d. None of these	
	a.	
10.	**A fair six-sided die is rolled 6 times. What is the probability of getting all outcomes as unique?**	
	a. 0.01543	*b. 0.024569*
	c. 0.04562	*d. 0.03562*

HOT* (Higher Order Thinking) Questions

CO Mapped – CO5

1. **Probability density function of a random variable *X* is given below**

$f(x)=\{0.25\ ,\quad 1\leq x\leq 5$

$=0\quad$ otherwise

P(X≤4) is

a. 3/4
b. 1/2
c. 1/4
d. 1/8

2. The probability density function of a random variable, $ x $ is

$f(x)=\frac{x}{4}(4-x^2)\quad$ for $0\leq x\leq 2$

$=0\quad$ otherwise

The mean, μ_x of the random variable is _____

3. If f(x) and g(x) are two probability density functions,

$f(x) = x/a+1 : -a \leq x < 0$

$-x/a+1 : 0 \leq x < a$

$0 : \text{otherwise}$

$g(x) = -x/a : -a \leq x < 0$

$x/a : 0 \leq x < a$

$0 : \text{otherwise}$

Which one of the following statements is true ?

a. Mean of $f(x)$ and $g(x)$ are same; Variance of $f(x)$ and $g(x)$ are same
b. Mean of $f(x)$ and $g(x)$ are same; Variance of $f(x)$ and $g(x)$ are different
c. Mean of $f(x)$ and $g(x)$ are different; Variance of $f(x)$ and $g(x)$ are same
d. Mean of $f(x)$ and $g(x)$ are different; Variance of $f(x)$ and $g(x)$ are different

4. A two-faced fair coin has its faced designated as head (H) and tail(T). This coin is tossed three times in succession to record the following outcomes. H, H, H. If the coin is tossed one more time. the probability (up to one decimal place) of obtaining H again, given the previous realizations of H, H and H would be _____

2. Name of the Course – Control System

Weekly Work Load(in Hrs)	**Lecture**	**Tutorial**	**Practical**			
	3 Lectures / Week		**2 Hrs. / Week**			
In-Sem	**Theory**	**Practical**	**Oral**	**Term-work**	**Total Marks**	**Credit**
30	**70**	**25**			**125**	**3**

2.1 Syllabus

Unit I : Introduction to Control Systems & its modelling

Basic Elements of Control System, Open loop and Closed loop systems, Differential equations and Transfer function, Modeling of Electric systems, Translational and rotational mechanical systems, Block diagram reduction Techniques, Signal flow graph.

Unit II : Time domain analysis

Time domain analysis: transient response and steady state response, standard test inputs for time domain analysis, order and type of a system, transient analysis of first and second order systems, time domain specifications of second order under damped system from its step response, Steady state error and static error constants.

Unit III : Stability Analysis

Characteristic equation of a system, concept of pole and zero, response of various pole locations in s-plane, concept of stability absolute stability, relative stability, stability of system from pole locations, Routh Hurwitz stability criterion, Root locus: definition, magnitude and angle

conditions, construction of root locus, concept of dominant poles, effect of addition of pole and zero on root locus. Application of root locus for stability analysis.

Unit IV :Frequency Response Analysis

Frequency response and frequency domain specifications, correlation between time domain and frequency domain specifications, polar plot, Nyquist stability criterion and construction of Nyquist plot, Bode plot, determination of frequency domain specifications and stability analysis using Nyquist plot and Bode plot

Unit V : State space representation

State space advantages and representation, Transfer function from State space, physical variable form, phase variable forms: controllable canonical form, observable canonical form, Solution of homogeneous state equations, state transition matrix and its properties, computation of state transition matrix by Laplace transform method only.

Unit VI :**Controllers And Digital Control Systems**

Concept of Controller, Basic ON-OFF Controller, Concept of Dead Zone, Introduction to P, I, D, PI, PD and PID controller, OFFSET of Controller, Integral Reset, PID Characteristics. Concept of Zeigler-Nicholas method. Concept of Industrial Automation, Need of IoT based Industrial Automation.

2.2 Course Objectives

1. To elaborate elements of control system and their modeling using various techniques. (Unit-1)
2. To Describe the methods for analyzing stability of system using the time response and frequency response.(Unit-2,3,4)
3. To introduce state variable analysis techniques for systems. (Unit-5)
4. To discuss concepts of PID controllers and its use for IOT based industrial automation.(Unit-6)

2.3 Course Outcomes

After successful completion of the course students will be able to-

CO1: Describe elements of control systems and their modeling using various techniques. **BTL-2(Understand)** (Unit-1)

CO2: Determine the system stability using time and frequency response. **BTL- 2(Understand)** (Unit-2,3,4)

CO3: Analyze systems using state space representation techniques. **BTL- 2(Understand)** (Unit-5)

CO4: Explain the role of PID controllers in IOT based industrial automation. **BTL-2 (Understand)** (Unit-6)

2.4 Text Books

1. N. J. Nagrath and M. Gopal, "Control System Engineering", New Age International Publishers, 5th Edition.

2. K. Ogata, "Modern Control Engineering", Prentice Hall India Learning Private Limited; 5th Edition.

2.5 Reference Books

1.Benjamin C. Kuo, "Automatic control systems", Prentice Hall of India, 7th Edition,1995

2.M. Gopal, "Control System – Principles and Design", Tata McGraw Hill, 4th Edition, 2012

3.Schaum's Outline Series, "Feedback and Control Systems" Tata McGraw-Hill, 2007.

4.John J. D'Azzo& Constantine H. Houpis, "Linear Control System Analysis and Design", Tata McGraw-Hill, Inc., 1995

5.Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Addison – Wesley, 1999

2.7 Teaching Plan

Sr. No.	Unit	Topics to be covered	Total Lecture Planned	CO Mapped	CA-PI Mapped
1	**1**	**Unit I : Introduction to Control Systems & its modelling** Basic Elements of Control System, Open loop and Closed loop systems, Differential equations and Transfer function, Modeling of Electric systems, Translational and rotational mechanical systems, Block diagram reduction Techniques, Signal flow graph.	**6**	**CO1**	**1.1.1** **1.4.1** **2.1.3**
2	**2**	**Unit II : Time domain analysis** Time domain analysis: transient response and steady state response, standard test inputs for time domain analysis, order and type of a system, transient analysis of first and second order systems, time domain specifications of second order under damped system from its step response, Steady state error and static error constants.	**6**	**CO2**	**1.1.1** **1.4.1** **2.1.2** **2.1.3**
3	**3**	**Unit III : Stability Analysis** Characteristic equation of a system, concept of pole and zero, response of various pole locations in s-plane, concept of stability absolute stability, relative stability, stability of system from pole locations, Routh Hurwitz stability criterion, Root locus: definition, magnitude and angle conditions, construction of root locus, concept of dominant poles, effect of addition of pole and zero on root locus. Application of root locus for stability analysis.	**8**	**CO2**	**1.1.1** **1.4.1** **2.1.2** **2.1.3**
4	**4**	**Unit IV :Frequency Response Analysis** Frequency response and frequency domain specifications, correlation between time domain and frequency	**8**	**CO2**	**1.1.1** **1.4.1** **2.1.2** **2.1.3**

		domain specifications, polar plot, Nyquist stability criterion and construction of Nyquist plot, Bode plot, determination of frequency domain specifications and stability analysis using Nyquist plot and Bode plot			
5	**5**	**Unit V : State space representation** State space advantages and representation, Transfer function from State space, physical variable form, phase variable forms: controllable canonical form, observable canonical form, Solution of homogeneous state equations, state transition matrix and its properties, computation of state transition matrix by Laplace transform method only.	**6**	**CO3**	**1.1.1 1.1.2 2.1.3**
6	**6**	**Unit VI :Controllers And Digital Control Systems** Concept of Controller, Basic ON-OFF Controller, Concept of Dead Zone, Introduction to P, I, D, PI, PD and PID controller, OFFSET of Controller, Integral Reset, PID Characteristics. Concept of Zeigler-Nicholas method. Concept of Industrial Automation, Need of IoT based Industrial Automation.	**6**	**CO4**	**1.4.1 2.2.4**

2.8 Unit wise Lecture Plan

2.8 a. -Unit No.-I- Introduction to Control Systems & its modelling

Pre-requisites: -

1. Basic Knowledge of Mechanical Systems in Engineering Mechanics subject of FE
2. Basic Knowledge of Feedback Systems in Basic Electronics Engineering subject of FE

Objectives: -

Introduce and describe the fundamentals of control systems, its elements and their modeling using various Techniques.

Outcomes: -

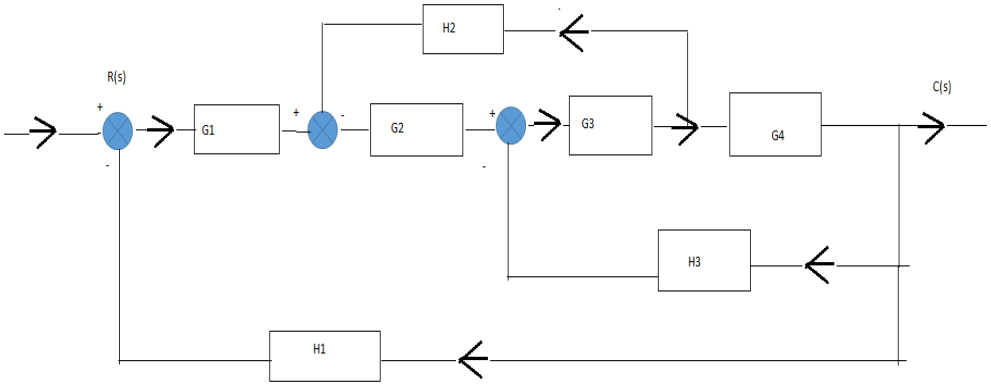
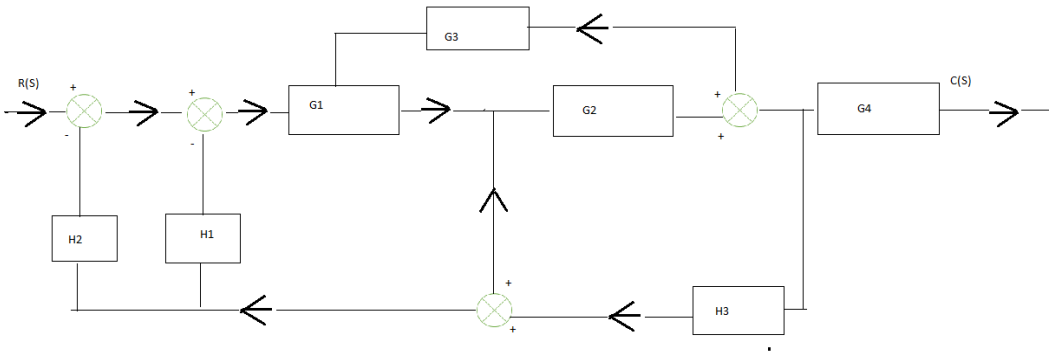
1. Define and distinguish the types of control systems and their application
2. Determine and use models of physical systems in forms suitable for use in the analysis and design of control systems.

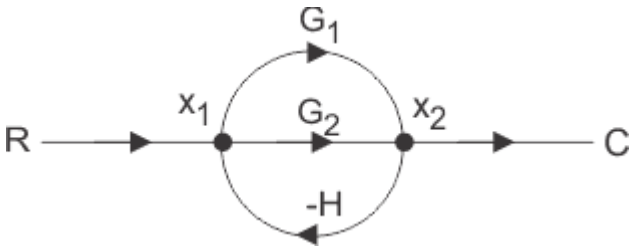
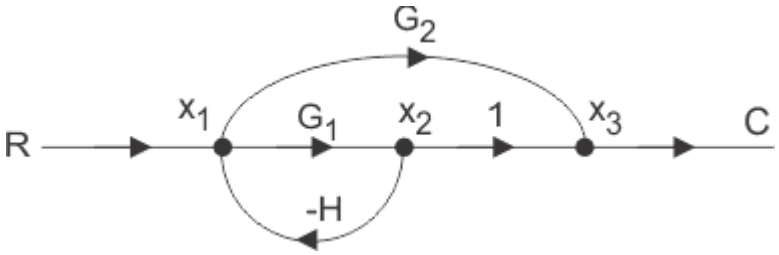
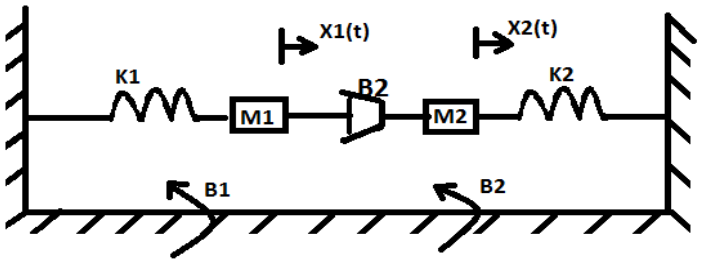
Lecture No.	Details of the Topic to be covered	References
1	Basic Elements of Control System, Open loop and Closed loop systems, Differential equations and Transfer function, Modeling of Electric systems, Translational and rotational mechanical systems, Block diagram reduction Techniques, Signal flow graph	**T1,R1**
2	Differential equations and Transfer function	
3,4	Modeling of Electric systems	
5	Translational and rotational mechanical systems	
6	Block diagram reduction Techniques	
7,8	Signal flow graph	

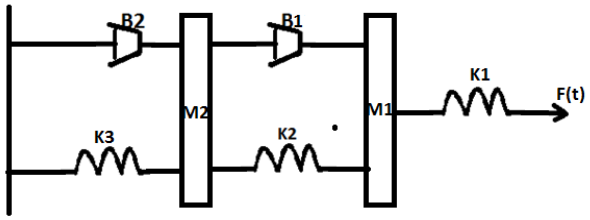
Question Bank: Theory

All Question Mapped with CO1 (1.1.1, 1.4.1, 2.1.3)

Q. 1	Explain open loop and closed loop system with one example. Write advantages disadvantages
Q. 2	Differences between Open loop system& closed loop system

Q. 3	Explain transfer function with its properties.
Q. 4	Define the following terms – linear system ,non-linear system
Q. 5	Differences between feed forward and feedback control system.
Q.6	Explain transfer function with its properties.
Q. 7	Reduce the following diagram into using block reduction techniques and find out T.F 1.  2.. 
Q. 8	Write any five block reduction techniques.

Q. 9	Find T.F by mason's gain formula 1.  2. 
Q.10	for the given system, obtain equivalent mechanical system, write the force equation and obtain its electrical equivalent circuit 
Q11	For the given system, obtain equivalent mechanical system write the force equations and obtain its electrical equivalent circuit, using F-I and F-V analogy.

	
Q12	A system described by the following differential equation $d2ydt2+3dydt+2y=(t)$ is initially at rest. For input $x(t)=2u(t)$, find the output y(t) .
Q.13	The unit-step response of a system starting from rest is given by $c(t) = 1 - e-2t$ for $t \geq 0$ What is transfer function of the system
Q.14	A linear, time-invariant, causal continuous time system has a rational transfer function with simple poles at s = -2 and s = -4, and one simple zero at s = -1. A unit step u(t) is applied at the input of the system. At steady state, the output has constant value of 1. What is impulse response of this system?

2.8 b. - Unit No.-II: Time domain analysis

Pre-requisites:- Basic Knowledge of types of Standard Inputs in Signal and system subject of

Objectives:-To introduce methods for analyzing the time response of the control systems.
Outcomes: - Understand and explain the relationship between control system parameters and transient behavior.

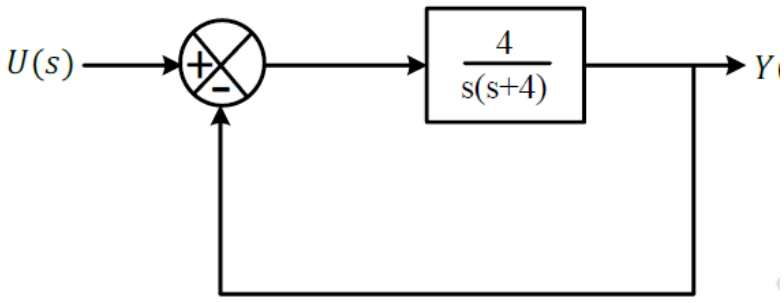
Lecture No.	Details of the Topic to be covered	References
1	transient response and steady state response, ,	T1,R2

2	standard test inputs for time domain analysis, order and type of a system	
3,4	transient analysis of first and second order systems,	
5	time domain specifications of second order under damped system from its step response,	
6,7	Steady state error and static error constants.	

Question Bank: Theory

All Question Mapped with CO2 (1.1.1, 1.4.1, 2.1.2, 2.1.3)

Q.1	Write short note on time domain specification and obtain the expression for any two of then
Q.2	Write short note on standard test signals consider for error calculation analysis
Q.3	Obtain expression for steady state error for closed loop system.
Q.4	Derive the expression for first order system to step ,ramp and parabolic inputs
Q.5	What are disadvantage of static error coefficient
Q.6	For unity feedback system having open loop transfer function (G)=K(S+2)/S(S^3+7S^2+12S) Find-i) Type of system ii) Error coefficient iii) Steady state error when input to the system R/2t^2
Q.7	Find time domain specification for C(s)/R(s)=1/(S^2+S+1)
Q.8	State the effect of adding poles and zeros.
Q.9	Explain what you mean by steady state error and error coefficients

Q.10	Obtain the response of second order system to step input.
Q.11	A unity-feedback control system has the open-loop transfer function (s) =4(1+2s)2(S+2) if the input to the system is a unity ramp, Find the steady-state error for given system.
Q.12	For a second-order system with the closed-loop transfer function (s)=9s2+4s+9 .what is the settling time for 2-percernt band, in seconds.
Q.13	Match the following codes with List-I with List-II: List – I (a) Very low response at very high frequencies (b) Over shoot (c) Synchro-control transformer output List – II (i) Low pass systems (ii) Velocity damping (iii) Natural frequency (iv) Phase-sensitive modulation (v) Damping ratio
Q.14	The unit impulse response of a linear time invariant system is the unit step function u(t). For t > 0,what is response of the system to an excitation $e-atu(t)$,a>0
Q.15	For the second order closed-loop system shown in the figure, the natural frequency (in rad/s) is 

2.8 c. - Unit No.-III: Stability Analysis

Pre-requisites: -Basic knowledge of MII subject of FE.

Objectives: -

1. To introduce methods for analyzing the time response, the frequency response and the stability of systems.
2. To introduce the concept of root locus

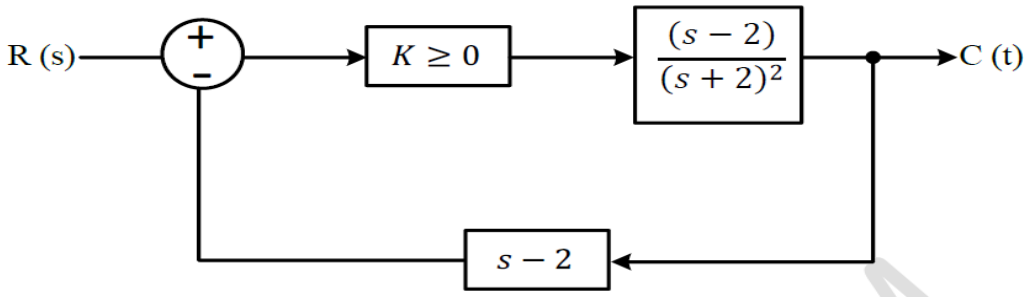
Outcomes: - Perform time domain and frequency domain analysis of control systems required for stability analysis.

Lecture No.	Details of the Topic to be covered	References
1	Concept of Stability	**T1,R3**
2	Routh-Hurwitz Criterion,	
3	Relative Stability, Dominant Poles	
4,	Root Locus Technique	
5,6	Construction of Root Locus,	
7	Application of Root Locus Diagram	

Question Bank: Theory

All Question Mapped with CO2 (1.1.1, 1.4.1, 2.1.2, 2.1.3)

Q. 1	Explain the condition for system stability.
Q. 2	Define the following term i) Absolute Stability ii) Relative stability iii) Marginal stability.
Q. 3	Using Routh –Hurwitz find the stability of the following system whose Characteristi equation $S^6+s^5+3s^4+3s^3+2s^2+s+1=0$
Q. 4	A unity Feedback system has $G(s)= k(s+1)/s^2(s+2)(s+5)$

	Determine the value of k for marginal stability.
Q. 5	The open loop T.F of a system is (G)(H)=k/s(s+2+2j)(s+2-2j) Determine the compete root locus and comments on stability
Q. 6	Explain the method to determine breakaway point in root locus.
Q. 7	Sketch the root locus for the system having (G)(H)=k/s(s^2+2s+2) Comment on stability.
Q. 8	Sketch the root locus of a unity feedback control system with (G)=k/s(s+1)(s+3) Determine the value of k for marginal stability
Q. 9	The open – loop transfer function of a unity – gain feedback control system is given by $G(s)=K/(s+1)(s+2)$ Calculate the gain margin of the system in dB.
Q.10	The feedback control system in the figure is stable find the rang of K 

1.8 d. - Unit No.-IV: Frequency Response Analysis

Objectives:-

1. To introduce methods for analyzing the time response, the frequency response and the stability of systems.
2. To introduce the concept of Bode plots, Nyquist plots.

Outcomes:-

1. Determine the frequency response to evaluate the system stability using graphical and analytical tools.

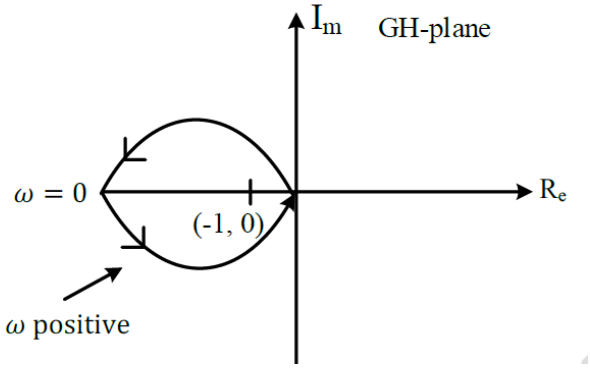
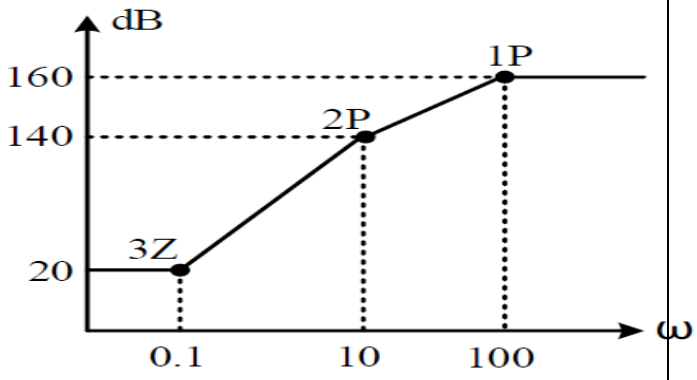
Perform time domain and frequency domain correlation analysis

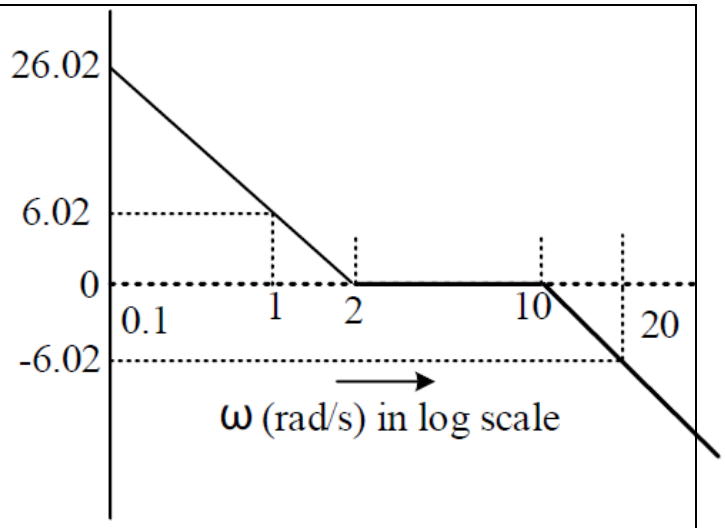
Question Bank: Theory

All Question Mapped with CO3 (1.1.1, 1.4.1, 2.1.2, 2.1.3)

Lecture No.	Details of the Topic to be covered	References
1	Frequency domain Versus Time domain analysis and its correlation	**T1,R1,R2,**
2	Frequency Domain specifications from the plots	
3,4,	Bode Plots	
5,	Polar Plot.	
6,7	Development of Nyquist Plots	
8	Stability analysis from plots	
Q. 1	What is frequency response analysis and frequency domain specification?	
Q. 2	Define Gain cross over frequency and Phase cross over frequency	

Q. 3	Define phase margin and gain margin
Q. 4	Write a short note on correlation between Time Domain and Frequency domain specification.
Q. 5	Find Gain Margin and phase Margin for unity feedback system having $(G)= 10/s(1+0.1s)(1+0.05s.)$
Q. 6	The forward path transfer function of a unity feedback control system is $(G)= 100/S(S+6.54)$ Find the resonance peak (M_r), resonant frequency (Wr) and bandwidth of the closed loop system.
Q. 8	Compare gain Margin and Phase Margin, write its important with respect to stability.
Q. 9	A system has fourteen poles and two zeros. Its high frequency asymptote in its magnitude plot .find the slop in db.
Q.10	In the figure, the Nyquist pole of the open-loop transfer function $(s)(s)$ of a system is shown. If $G(s)H(s)$ has one right-hand pole, the closed-loop system is

	
Q.11	The approximate Bode magnitude plot of a minimum – phase system is shown in the figure. The transfer function of the system is 
Q. 12	The Bode asymptotic magnitude plot of a minimum phase system is shown in this figure. If the system is connected in a unity negative feedback configuration, the steady state error of the closed loop system, to a unit ramp input, is ____.

	
Q. 13	The open-loop transfer function of a feedback control system is $G(s).H(s)=1(s+1)3$ Find the gain margin of the system .

2.8 e. - Unit No.-V: State Variable Analysis

Pre-requisites:- Basic knowledge of MII subject of FE.

Objectives:- To introduce the state variable analysis method.

Outcomes:- Express and solve system equations in state variable form.

Lecture No.	Details of the Topic to be covered	References
1	State space advantages and representation,	**T1,R2**
2	Concepts of Transfer function from State space	

3,4,	physical variable form, phase variable forms: controllable canonical form, observable canonical form, Solution of homogeneous state equations	
5,6	State transition matrix and its properties, computation of state transition matrix by Laplace transform method.	
7	Controllability and Observability.	

Question Bank: Theory

All Question Mapped with CO4

Q. 1	Define term a) State b) state variables c) state vector d) state space
Q. 2	What are the advantages of state space analysis over conventional control system analysis method
Q. 3	Write the properties of state transition matrix.
Q. 4	Write the solution of homogeneous and non –homogeneous state equation
Q. 5	Define controllability and observability
Q. 6	Write a note on kalman's Test.

Q. 7	Obtain the state transition matrix for the system X1= 0 1 x1 X2= -2 -3 x2

Q. 8	The system equations are given by X(t) = 0 1 x(t) + 0 u(t) Y(t)= 1 0 x(t) , Find the transfer function. -2 -3 1

Q. 9	**Obtain the state model using signal flow graph approach of a system where transfer function is $Y(S)/U(S) = 3s+4/s^2 +5s+6$**

Q. 10	**Write derivation of transfer function theory with state variables theory.**

Q. 11	**Explain the state model for MIMO control system with the help of block diagram.**

2.8 f. - Unit No.-VI: Controllers and Digital Control Systems

Objectives:-

1. To introduce concepts of PID controllers and digital and control systems.

2. To introduce concepts of programmable logic controller**.**

Outcomes:

1. Understand and design analog and digital controllers.

2. Solving problems using PLC Ladder Diagram.

Lecture No.	Details of the Topic to be covered	References
1	Introduction to PLC: Block schematic, PLC addressing	**R4,R5**
2	Any one application of PLC using Ladder diagram	
3,4	Introduction to PID controller: P, PI, PD and PID	
4	Characteristics and concept of Zeigler-Nicholas method.	
5,6	Digital control systems: Special features of digital control systems, Necessity of sample and hold operations for computer control	
6	z-transform and pulse transfer function	
7,8	Stability and response of sampled-data systems.	

Question Bank: Theory

All Question Mapped with CO4

Q. 1	Write a note on PID controller.
Q. 2	Draw and explain the architecture of PLC
Q. 3	Sketch and comment on the output of P,PI,PID controller for a unit step &ramp I/P
Q. 4	Draw a ladder diagram for an elevator system and explain it.
Q. 5	Differentiate between PLC&PC
Q. 6	Draw a relay ladder diagram for motor with

	1.NO start button 2.NC stop button 3. Thermal overload limit open on high temperature. 4. Green light while running 5. Red light for thermal overload 6.Convert this in to a PLC ladder diagram
Q. 7	With suitable block diagrams and equation, explain the following types of controller employed in control system. I. Proportional controller II. Proportional+ Integral controller III. PID Controller IV. Integral controller
Q. 8	With suitable block diagrams and equation, explain the following types of controller employed in control system. V. Proportional controller VI. Proportional+ Integral controller VII. PID Controller VIII. Integral controller
Q.11	Write down the advantage of digital control system over analog.
Q. 12	Draw a ladder diagram for an elevator system and explain it.
Q. 13	Draw & explain the ladder diagram for the system having the following specification 1.Tank level control system in which a bottle is filed by opening the outlet valve.

	2.The bottles are coming for filing one after the other periodically 3.Assume 1 min prefill for initialization

3.Name of the Course – Principles of Communication Systems

Weekly Work Load(in Hrs)	Lecture	Tutorial	Practical
	3 Hrs/ Week	--	2 Hrs/Week

In-sem (Theory)	End-sem (Theory)	Practical	Total Marks	Credit
30 marks	**70 marks**	**50 marks**	**150 marks**	**3 + 1**

3.1 Syllabus

Unit I: Signals & spectra (8 L)

Introduction to Communication System, Analog and Digital messages, regenerative repeaters, Signal Bandwidth & Power. Size & classification of signal, exponential Fourier series, concept of negative frequencies. Fourier transform and properties, Frequency shifting, Concept of baseband and bandpass signals, Signal transmission through LTI system. Signal energy & Energy Spectral density. Signal power & Power Spectral Density, Input and output PSD, PSD of modulated signal.

Unit II: AM transmission & reception for signal tone (8 L)

Need for frequency translation, Amplitude modulation (DSB-C), Double sideband Suppressed carrier (DSB-SC) modulation, Single sideband modulation (SSB), Vestigial Sideband modulation (VSB),Spectrum and Bandwidth of AM, DSB-SC, SSB & VSB, Calculation of modulation index for AM wave, Modulation index for more than one modulating signals, Power and power efficiency, AM reception.

Unit III: FM transmission & reception for signal tone (8 L)

Phase Modulation (PM) and Frequency Modulation (FM), Relationship between Phase and Frequency Modulation, Modulation Index, Spectrum of FM (single tone): Feature of Bessel Coefficient, Power of FM signal, Bandwidth of tone modulated FM signal, modulation index: AM vs. FM, Spectrum of constant Bandwidth‟ FM, Narrowband and Wideband FM.

FM Modulators and Demodulators: FM generation by Armstrong's Indirect method, frequency multiplication and application to FM, FM demodulator.

Unit IV: Pulse Modulation (6 L)

Need of analog to digital conversion, sampling theorem for low pass signal in time domain, and Nyquist criteria, Types of sampling- natural and flat top. Pulse amplitude modulation & concept of TDM: Channel

bandwidth for PAM, equalization, Signal Recovery through holding. Pulse Width Modulation (PWM) and Pulse Position Modulation (PPM): Generation & Detection.

Unit V: Digital Representation of Analog Signals (6 L)
Quantization of Signals: Quantization error, Uniform & Non-Uniform types of Quantization, Mid-rise & Mid-tread Quantizer. **Companding:** A-law & μ-law. **Pulse Code Modulation system**: Generation & Reconstruction, Differential Pulse code modulation, Delta Modulation, Adaptive Delta Modulation.

Unit VI: Baseband Digital Transmission (6 L)
Line codes: Properties and spectrum. **Digital Multiplexing and hierarchies:** T1, AT&T, E1, CCITT, Scrambling & Unscrambling. **Synchronization:** Carrier Synchronization, Bit Synchronization and Frame Synchronization. Intersymbol Interference, Equalization.

3.2 Course Objectives

- To familiarize with basic mathematical tools for time and frequency domain analysis of signals.
- To acquaint with the fundamental principles of modulation process and different amplitude and frequency modulation systems.
- To introduce with the concept of Sampling theorem and pulse modulation techniques like PAM, PWM, PPM.
- To impart pre-requisites of digital communication systems and explore digital representation techniques like PCM, DPCM, DM and ADM.
- To explain the techniques of waveform coding, multiplexing and synchronization in baseband digital transmission.

3.3 Course Outcomes

At the end of the course the Student will be able to:

- Describe various parameters (power, BW, energy, PSD) of signals in communication systems. (U1) (BTL – 2, Understand)
- Describe the AM and FM systems with mathematical analysis. (U2, U3) (BTL – 2, Understand)
- Explain the sampling theorem and various pulse modulation techniques. (U4) (BTL – 2, Understand)
- Explain the various Digital Modulation techniques. (PCM, DPCM, DM, ADM). (U5) (BTL – 2, Understand)
- Illustrate Describe the techniques of waveform coding, multiplexing and synchronization in baseband digital transmission. (U6) (BTL – 2, Understand)

3.4 Text Books

T1. Taub, Schilling and Saha, “Principles of Communication Systems”, McGraw-Hill, 4th Edition.

T2. B P Lathi, Zhi Ding, “Modern Analog and Digital Communication System”, Oxford University Press, 4th Edition.

3.5 Reference Books

R1. Bernard Sklar and Prabitra Kumar Ray, "Digital Communications Fundamentals and Applications", Pearson Education 2nd Edition.
R2. Wayne Tomasi, "Electronic Communications System", Pearson Education, 5th Edition.
R3. A. B. Carlson, P B Crully and J C Rutledge, "Communication Systems", Tata McGraw Hill Publication, 5th Edition.
R4. Simon Haykin, "Communication Systems", John Wiley & Sons, 4th Edition.

3.6 Reference Web Links/ Research Paper/ Referred Book other than Mention in Syllabus

1. MIT OPENCOURSEWARE (ocw.mit.edu/courses/electrical-engineering)
2. https://ocw.mit.edu/courses/find-by-topic/#cat=engineering&subcat=electricalengineering&spec=telecommunications
3. nptel.ac.in/courses/108104091/

3.7 Teaching Plan

Sr. No.	Unit	Topics to be covered	Book Referred	Total Lecture Planned	CO Mapped
1	1	Introduction to Communication System, Analog and Digital messages, regenerative repeaters	T2	1	CO1
2		Signal Bandwidth & Power. Size & classification of signal		2	
3		exponential Fourier series, concept of negative frequencies		3	
4		Fourier transform and properties, Frequency shifting		4	
5		Concept of baseband and bandpass signals, Signal transmission through LTI system		5	
6		Signal energy & Energy Spectral density		6	
7		Signal power & Power Spectral Density		7	
8		Input and output PSD, PSD of modulated signal		8	
9	2	Need for frequency translation, Amplitude modulation (DSB-C)	T1, T2	9	CO2
10		Double sideband Suppressed carrier (DSB-SC) modulation		10	
11		Single sideband modulation (SSB)		11	
12		Vestigial Sideband modulation (VSB)		12	
13		Spectrum and Bandwidth of AM, DSB-SC, SSB & VSB		13	

14		Calculation of modulation index for AM wave		14	
15		Modulation index for more than one modulating signals, Power and power efficiency		15	
16		Problems		16	
17		AM reception		17	
18	3	Phase Modulation (PM) and Frequency Modulation (FM), Relationship between Phase and Frequency Modulation	T1, T2	18	CO2
19		Modulation Index, Spectrum of FM (single tone): Feature of Bessel Coefficient		19	
20		Power of FM signal, Bandwidth of tone modulated FM signal		20	
21		Modulation index: AM vs. FM, Spectrum of constant Bandwidth FM		21	
22		Narrowband and Wideband FM		22	
23		FM Modulators and Demodulators: FM generation by Armstrong's Indirect method		23	
24		Frequency multiplication and application to FM		24	
25		FM demodulator		25	
26	4	Need of analog to digital conversion, sampling theorem for low pass signal in time domain	R2	26	CO3
27		Nyquist criteria, Types of sampling- natural and flat top		27	
28		Pulse amplitude modulation, Channel bandwidth for PAM		28	
29		Pulse Width Modulation (PWM) and Pulse Position Modulation (PPM): Generation & Detection		29	
30		Concept of TDM		30	
31		Equalization, Signal Recovery through holding		31	
32	5	Quantization of Signals: Quantization error, Uniform & Non-Uniform types of Quantization	R1, R2, R3	32	CO4
33		Mid-rise & Mid-tread Quantizer, Companding: A-law & μ-law		33	
34		Pulse Code Modulation system: Generation & Reconstruction		34	
35		Differential Pulse code modulation, Delta Modulation, Adaptive Delta Modulation		35	
36	6	Line codes: Properties and spectrum		36	CO5

		Digital Multiplexing and hierarchies: T1, AT&T, E1, CCITT	R1, R2		
37		Scrambling & Unscrambling, Synchronization: Carrier Synchronization, Bit Synchronization and Frame Synchronization		37	
38		Intersymbol Interference, Equalization		38	

3.8 Unit wise Lecture Plan

3.8 a. Unit No - I

Pre-requisites: -

- Fourier Transform and its properties

Objectives: -

- To introduce Communication System, types of messages
- To describe various parameters of signals
- To equip/ familiarize students with basic mathematical tools for time and frequency domain analysis of communication signal and systems

Outcomes: - Describe various parameters (power, BW, energy, PSD) of signals in communication systems.

PI Mapped: - 1.3.1, 1.4.1, 2.1.2, 2.1.3

Lecture No.	Details of the Topic to be covered	References	CO Mapped
1	Introduction to Communication System, Analog and Digital messages, regenerative repeaters	**T2**	**CO1**
2	Signal Bandwidth & Power. Size & classification of signal		
3	Exponential Fourier series, concept of negative frequencies		
4	Fourier transform and properties, Frequency shifting		
5	Concept of baseband and bandpass signals, Signal transmission through LTI system		
6	Signal energy & Energy Spectral density		
7	Signal power & Power Spectral Density		
8	Input and output PSD, PSD of modulated signal		

Question Bank: Theory

Q. No.	Question	Marks	CO Mapped
Unit I			
1	Explain the block diagram of Communication System.	6	CO1

2	Differentiate between Analog and Digital messages.	6	
3	Explain the role of regenerative repeaters.	6	
4	Explain signal bandwidth and its power.	4	
5	What is the concept of negative frequencies? Explain its significance.	4	
6	Describe the properties of Fourier Transform.	6	
7	Explain the concept of baseband and bandpass signals.	4	
8	How is the transmission of signal through LTI system? Explain.	6	
9	Compare and contrast between the signal energy and signal power.	6	
10	Compare and contrast between the energy spectral density and power spectral density.	6	

Oral Questions
(CO Mapped – CO1)

Q 1. What are Analog and Digital messages?
Q 2. Why Regenerative repeaters are required? Are they feasible for both analog and digital systems?
Q 3. Define Signal Bandwidth.
Q 4. What is a signal? Classify them.
Q 5. What is the concept of negative frequencies?
Q 6. What are Fourier transform properties?
Q 7. What are baseband and bandpass signals?
Q 8. What is an LTI system?
Q 9. Define Signal energy & Energy Spectral density.
Q 10. Define Signal power & Power Spectral Density.
Q 11.Draw and explain differences in Continuous time and Discrete time signal.
Q 12.Draw and explain differences in Analog and Digital signal.
Q 13.Draw and explain differences in Periodic and Non-periodic signal.
Q 14.Draw and explain differences in Energy and Power Signals.
Q 15. Differentiate between Energy and Power Signals.
Q 16.Draw and explain differences in Deterministic and Random signal.
Q 17. Differentiate between Deterministic and Random signal

3.8 b. Unit No – II

Pre-requisites: -

- Fourier Transform and its properties

Objectives:-

- To acquaint with the fundamental principles of modulation process and different amplitude modulation systems
- Comparison and analysis of Amplitude modulation techniques

Outcomes: - Describe the AM and FM systems with mathematical analysis.

PI Mapped: - 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.4

Lecture No.	Details of the Topic to be covered	References	CO Mapped
1	Need for frequency translation, Amplitude modulation (DSB-C)	**T1, T2**	**CO2**
2	Double sideband Suppressed carrier (DSB-SC) modulation		
3	Single sideband modulation (SSB)		
4	Vestigial Sideband modulation (VSB)		
5	Spectrum and Bandwidth of AM, DSB-SC, SSB & VSB		
6	Calculation of modulation index for AM wave		
7	Modulation index for more than one modulating signals, Power and power efficiency		
8	Problems		
9	AM reception		

Question Bank: Theory

Q. No.	Question	Marks	CO Mapped
	Unit I		
1	For a baseband signal m(t)cos(wmt), find the DSBSC signal and sketch its spectrum. Identify the USB and LSB.	6	CO2
2	What do you mean by ISB and VSB? Also explain their generation methods.	6	
3	Derive the expression for AM, Sketch the waveform and explain power relations for DSB-FC.	6	
4	A carrier wave Vc = 4 Sin (2π x 500 x 103t) is AM modulated by audio wave Vm = 0.2 Sin 3[(2π x 500t) + 0.1 Sin 5(2π x 500t)]. Determine the upper and lower sidebands and sketch the complete spectrum of the modulated wave. Estimate total power in sidebands.	5	
5	Explain Independent sideband system with help of block diagram.	5	
6	Define modulation. State various types of modulation schemes along with their waveforms.	4	
7	State and compare different SSB generation methods.	6	
8	With neat diagram explain ring modulator for DSBSC generation. Draw waveform and spectrum for DSBSC.	6	
9	An AM transmitter has carrier of 500 W which is modulated upto a depth of 40%. Find the total power in the transmitted wave.	5	
10	What is baseband transmission? What are its limitations?	6	
11	Compare between AM, FM and PM.	10	
12	Explain AM broadcast technical standards.	5	
13	Explain the phase shift method for generating SSB-SC. State its advantages and disadvantages.	6	
14	Compare between DSB-FC, DSB-SC and SSB-SC.	6	

15	What is carrier communication? Explain the types of the same.	6	

Oral Questions
(CO Mapped – CO2)

Q 1. What is modulation? Its types. Need for modulation.
Q 2. Explain block diagram of basic communication systems
Q 3. What is AM? Draw the waveforms for DSB-FC, DSB-SC and SSB signals in time and frequency domain.
Q 4. Write equation for AM.
Q 5. Give the broadcast range for AM.
Q 6. Give the audio range.
Q 7. Give the voice range.
Q 8. Give the need for modulation.
Q 9. Types of AM system.
Q 10. BW required for AM.
Q 11. Use of balanced modulator in case of AM
Q 12. Draw 100% modulated waveform and DSB-SC waveform and differentiates.
Q 13. Define modulation index. Its equation. Formula. How practically m is measured? Why do we use trapezoidal method?
Q 14. What is the maximum power transmitted by AM?
Q 15. Prove power saving is 66.66% if the sidebands are suppressed. Derive.
Q 16. What if carrier and side-bands are suppressed?
Q 17. Differentiate between AM transmitter and modulator.
Q 18. What is DSB-SC? Advantages. It's BW.
Q 19. What is SSB? Advantages. It's BW.
Q 20. What is VSB? Its applications. It's BW.
Q 21. Types of generation of SSB? Advantages. It's BW.
Q 22. Block diagram of SSB generation methods.
Q 23. Give the types of balanced modulators.

MCQs

Question	Choose the correct statement in AM
A	Sideband power is always constant
B	Transmitted power is always constant
C	Carrier power is constant
D	Bandwidth is infinite
Answer	C
Marks	1
CO mapped	II

Question	The amplitude modulator works on the principle of
A	Multiplication
B	Addition
C	Subtraction

D	division
Answer	A
Marks	1
CO mapped	II

Question	Let m(t) be band limited to fm Hz. The bandwidth requirement of the signal m(t)cos2Πfct
A	fm
B	fm/2
C	2fm
D	fc
Answer	C
Marks	1
CO mapped	II

Question	Video signal in TV are
A	Amplitude modulated
B	Frequency Modulated
C	Demodulated
D	Unmodulated
Answer	A
Marks	1
CO mapped	II

Question	The carrier power of an AM wave is 6 KW,with modulation index of 0.5, the total transmitted power is
A	8 KW
B	6.75 KW
C	8.75 KW
D	9 KW
Answer	B
Marks	1
CO mapped	II

Question	Why Class C amplifier is used in AM Generation
A	High efficiency
B	Low efficiency
C	Low fidelity
D	High response
Answer	A
Marks	1
CO mapped	II

Question	SSB-SC modulation is not used for audio broadcasting because
A	It is difficult to generate SSB-SC signal
B	It makes the receiver circuit quiet complex and expensive
C	SSB-SC modulation cannot be used for speech signal
D	None of the above
Answer	B
Marks	1
CO mapped	II

Question	A carrier wave of 10 MHz frequency and peak value of 10 V is amplitude modulated by a 5 KHz sine wave of 6V amplitude. Its modulation index is
A	1.66
B	0.6
C	4
D	0.6 V
Answer	B
Marks	1
CO mapped	II

Question	For a 100%, AM modulated wave with carrier suppressed, the percentage power saving will be
A	100
B	50
C	150
D	66.66
Answer	D
Marks	1
CO mapped	II

Question	Given an AM radio signal with a bandwidth of 10 KHz and the highest-frequency component at 705 KHz, what is the frequency of the carrier signal?
A	700 kHz
B	705 kHz
C	710 kHz
D	Cannot be determined
Answer	A
Marks	1
CO mapped	II

Question	Which of the following is not an advantage of the phase method over the filter method in producing SSB?

A	The design of the 90º phase-shift network for the intelligence frequencies is simple
B	Lower intelligence frequencies can be economically used, because a high-Q filter is not necessary.
C	Intermediate balanced modulators are not necessary, because high-Q filters are not needed
D	It is easier to switch from one sideband to the other.
Answer	A
Marks	1
CO mapped	II

Question	What is the difference between a balanced modulator and a regular modulator?
A	There is no carrier produced in the output of a balanced modulator
B	In a balanced modulator, there is 180º phase shift between the upper and lower sidebands
C	In a balanced modulator, only one sideband is produced
D	In a balanced modulator, harmonics of the sidebands are suppressed
Answer	A
Marks	1
CO mapped	II

Q. No.	Question	Marks	CO Mapped
	Unit 2		
1	Explain the tracking methods in Super heterodyne radio receiver.	6	CO2
2	In a broadcast super heterodyne radio receiver, the loaded Q of the aerial coupling circuit at input of mixer is 125. If intermediate frequency 465 KHz. Calculate, i) Image Frequency and its rejection at 1 MHz and 30MHz ii) The IF required to make the Image rejection ratio as good at 30MHz as it is at 1MHz.	6	
3	The frequency span to be received is from 525 - 1650KHz. If Cmin of tuning circuit is limited to 50pf by a trimmer of 25pf. Calculate the value of padder capacitor. The max value of variable capacitor is 450pf, IF is 465KHz.	6	
4	Explain the characteristics of radio receivers.	6	
5	What are the different types of distortions that occur in a typical diode detector circuit? Explain with proper waveforms.	4	
6	Explain how a diode can be used to detect an AM signal. What are the different types of distortions that occur in a typical diode detector circuit?	4	
7	For tone modulation derive the equation for upper limit of RC to ensure the capacitor follows the envelope of an AM DSBFC wave.	6	
8	Explain with waveforms and block diagram AM super heterodyne receiver.	6	
9	Compare TRF and super heterodyne receivers.	6	

10	Explain with waveforms and block diagram Dual conversion super heterodyne receiver.	8	

Oral Questions
(CO Mapped – CO2)

Q 1. State the different AM detection techniques. Draw simple practical diode detector.
Q 2. Explain distortions observed in diode detector with reason.
Q 3. Why envelope detector is named so?
Q 4. Define selectivity.
Q 5. Define sensitivity.
Q 6. Define image rejection ratio.
Q 7. Define fidelity.
Q 8. Draw curves for receiver characteristics.
Q 9. List drawbacks of TRF receiver.
Q 10. How are the shortcomings of TRF receiver overcome?

MCQs

Question	A high value of IF for a Super heterodyne receiver
A	Improve image frequency rejection ratio
B	Improves the selectivity
C	Improves the sensitivity
D	Improves the fidelity
Answer	A
Marks	2
CO mapped	2

Question	F1 and F2 are the inputs of Mixer what is the o/p of mixer
A	F1 and F2
B	F1+F2
C	F1-F2
D	All of these
Answer	D
Marks	2
CO mapped	2

Question	The key difference between IF and audio amplifier is
A	The use of filtration component
B	Voltage requirements
C	Audio amplifiers usually are in IC form
D	Frequency of operation
Answer	D
Marks	1

CO mapped	2

Question	The frequency of input signal of a Superheterodyne AM receiver is 1000KHz, the local frequency required to tune the signal is.....
A	1455KHz
B	550KHz
C	570KHz
D	530KHz
Answer	A
Marks	2
CO mapped	2

Question	A Superheterodyne AM broadcast receiver has an IF of 455 KHz. If it is tuned to a frequency of 700 KHz, the image frequency is
A	1610KHz
B	1155KHz
C	245KHz
D	210KHz
Answer	A
Marks	1
CO mapped	2

Question	The negative tracking error is present in
A	Trimmer tracking
B	Padder tracking
C	Two point Tracking
D	None of these
Answer	A
Marks	1
CO mapped	2

Question	If the sensitivity for three receivers is 10μV, 12μV, 6μV respectively at 1000KHz which one is the most sensitive.
A	10μV
B	12μV
C	6μV
D	None of these
Answer	C
Marks	2

CO mapped	2

Question	AM receivers operate in which bands of frequencies?
A	Medium wave
B	Short wave
C	High frequency wave
D	both A and B
Answer	D
Marks	1
CO mapped	2

Question	RF carrier range for Medium wave band signal is
A	bellow 455k
B	455 to 1000k
C	535k to 1650k
D	above 1650k
Answer	C
Marks	1
CO mapped	2

3.8 c. Unit No.-III

Pre-requisites: -

- Fourier Transform and its properties
- Amplitude modulation and its advantages-disadvantages

Objectives: -

- To acquaint with the fundamental principles of modulation process and different frequency modulation systems

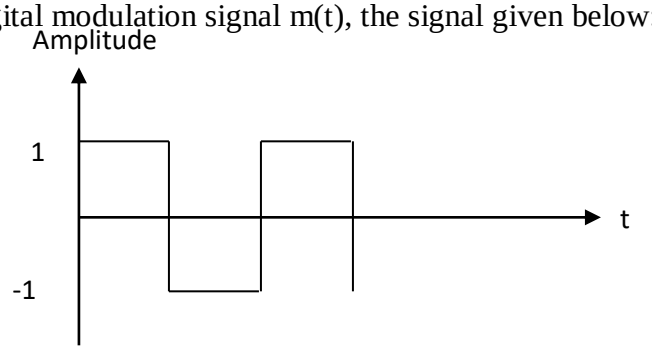
Outcomes: - Describe the AM and FM systems with mathematical analysis.

PI Mapped: - 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.4

Lecture No.	Details of the Topic to be covered	References	CO Mapped
1	Phase Modulation (PM) and Frequency Modulation (FM), Relationship between Phase and Frequency Modulation	**T1, T2**	**CO2**
2	Modulation Index, Spectrum of FM (single tone): Feature of Bessel Coefficient		
3	Power of FM signal, Bandwidth of tone modulated FM signal		

4	Modulation index: AM vs. FM, Spectrum of constant Bandwidth FM		
5	Narrowband and Wideband FM		
6	FM Modulators and Demodulators: FM generation by Armstrong's Indirect method		
7	Frequency multiplication and application to FM		
8	FM demodulator		

Question Bank: Theory

Q. No.	Question	Marks	CO Mapped
	Unit III		
1	Sketch Frequency Modulation (FM) and Phase Modulation (PM) waveform for the digital modulation signal m(t), the signal given below:  Figure 1 The constants kf and kp are ($2\pi * 10^5$) and ($\pi/2$) respectively and fc = 100 MHz. Calculate the frequencies present in the FM and PM waves. What is the limitation on the product kpm(t)?	6	CO2
2	Design and draw the block diagram of Armstrong indirect FM modulator to generate an FM carrier with a carrier frequency of 98.1 MHz and Δf = 75 KHz. A narrowband FM generator is available at a carrier frequency of 1000 KHz and Δf = 10 Hz with the oscillator having an adjustable frequency in the range of 10-11 MHz. Frequency doublers, triplers are available.	8	
3	Derive an expression for frequency and phase modulated wave. Sketch the Waveforms.	8	
4	An angle modulated signal is described by the equation $\psi EM(t) = 10 \cos (2\pi \mathbf{f_m} t + 4 \sin 2\pi fm t)$ where fc = 10 MHz and fm = 1000Hz. i) Determine the Modulation Index. Estimate the transmitted signal bandwidth ii) Repeat (i) fm is doubled.	5	
5	Explain the Direct method for FM generation with block diagram.	8	
6	Explain the Armstrong method of FM generation with suitable block diagram.	8	
7	Why is FM known as constant bandwidth system? Compare between NBFM and WBFM.	5	

8	A carrier $E_c cos\omega_c t$ is modulated by a signal $f(t) = 2cos2\pi t + 6cos10^3 2\pi t + 7cos10^3 4\pi t$. Find the bandwidth of FM using Carson's rule. Assume $K = 10 \times 10^3$ *Hz per volt*. Also find the 'deviation ratio'.	8	
9	A carrier is frequency modulated with a sinusoidal signal of 2 kHz resulting in frequency deviation of 5 kHz : (i) Find bandwidth of modulated signal. (ii) The amplitude of modulating sinusoid is increased by a factor of 3 and its frequency is halved. Find the maximum frequency deviation and bandwidth of new modulated signal.	8	
10	Describe threshold in angle modulation.	8	
11	With the help of mathematical expression explain which is superior PM/FM.	6	
12	Give the equation for FM and PM. Give the difference in bandwidth when: (i) Amplitude of modulating signal is doubled (ii) Frequency of modulating signal is halved.	6	
13.	An angle modulated signal with carrier frequency wc = (2 * π * 10^6) is described by the equation $\Phi_{EM}(t) = 10\cos(w_c t + 0.2\sin 1000\pi t)$ (i) Find the power of modulated signal, (ii) Find the modulation index, (iii) Find the frequency deviation, (iv) Estimate the bandwidth.	6	
14.	Explain with block diagram FM stereo transmitter.	6	

Oral Questions
(CO Mapped – CO2)

Q 1. Give the FM Broadcast range. How many sidebands are there? It's BW.
Q 2. Differentiate between high level modulation and low level modulation.
Q 3. Differentiate between Narrow band FM and wideband FM.
Q 4. Draw the waveforms for FM and PM. Explain the difference.
Q 5. Give the mathematical representation of FM. It's modulation index. Frequency deviation.
Q 6. Define the significant bands. What is the significant band in FM?
Q 7. Give the frequency spectrum of FM.
Q 8. What is pre-emphasis and de-emphasis?
Q 9. Draw the block diagram of Armstrong method
Q 10. Draw the diagram for varactor diode method
Q 11. State the radio channel ranges in Pune.
Q 12. If information signal is absent, what is the output of modulator?

MCQs

Question	In FM broadcasting, the peak frequency deviation and the maximum audio frequency handled, are respectively
A	75KHz, 10 KHz
B	75KHz, 15 KHz

C	200KHz, 10 KHz
D	75KHz, 5KHz
Answer	B
Marks	1
CO mapped	2

Question	Range of FM is
A	91.1MHz to 101MHz above 93.1 MHz
B	88Mhz to 108MHz
C	Above 93.1 MHz
D	None of these
Ans	B
Marks	1
CO mapped	2

Question	The amount of frequency deviation from the carrier center frequency in an FM transmitter is proportional to what characteristic of the modulating signal?
A	Amplitude
B	Frequency
C	Phase
D	shape
Answer	A
Marks	1
CO mapped	2

Question	Both FM and PM are types of what kind of modulation?
A	Duty Cycle
B	Amplitude
C	Phase
D	Angle
Answer	D
Marks	1
CO mapped	2

Question	The phenomenon of a strong FM signal dominating a weaker signal on a common frequency is referred to as the
A	Quieting factor
B	Blot out
C	Capture effect

D	Domination syndrome
Answer	C
Marks	1
CO mapped	2

Question	The maximum deviation of an FM carrier is 2KHz by a maximum modulating signal of 400Hz. The deviation ratio is
A	5
B	0.2
C	8
D	40
Answer	A
Marks	1
CO mapped	2

Question	A 100 MHz carrier is deviated 50 KHz by a 4KHz signal. The modulation index is
A	12.5
B	5
C	8
D	20
Answer	A
Marks	1
CO mapped	2
Question	The FM produced by PM is called
A	Indirect PM
B	Indirect FM
C	PM
D	FM
Answer	B
Marks	1
CO mapped	2

Question	Advantages of angle modulation over amplitude modulation are ---------
A	Noise reduction
B	More efficient use of power
C	Improved system fidelity
D	All of these
Answer	D
Marks	1
CO mapped	2

Question	Angle modulation is used for --------
A	Radio broadcasting
B	Cellular radio

C	Microwave communication
D	All of the above
Answer	D
Marks	1
CO mapped	2

Question	The only way to solve the expression for FM wave is to use----------
A	Fourier transform
B	Bessel's function
C	Laplace transform
D	Both A and C
Answer	B
Marks	1
CO mapped	2

Question	To produce frequency modulation using a phase modulator
A	The message signal must be integrated and then used for modulation
B	The message signal must be differentiated and then used for modulation
C	The phase modulated signal must be integrated
D	The phase modulated signal must be differentiated
Answer	A
Marks	1
CO mapped	2

Question	How many sidebands are present in spectrum of FM
A	Infinite
B	two
C	four
D	three
Answer	A
Marks	1
CO mapped	2

Question	The transmitted power in FM is

A	Dependent on number of sidebands
B	Always Constant
C	Dependent on carrier power
D	None of these
Answer	B
Marks	1
CO mapped	2

Question	Modulation Index of wide band FM system is …..
A	m=1
B	m>1
C	m<1
D	None of these
Answer	B
Marks	1
CO mapped	2

Question	For the broad casting application …..used
A	Narrowband FM
B	Wideband FM
C	PM
D	AM
Answer	B
Marks	1
CO mapped	2

Question	Armstrong method is …..
A	Direct method to generate a FM
B	Direct method to generate a PM
C	Indirect method to generate a PM
D	Indirect method to generate a FM
Ans	D
Marks	1
CO mapped	2

Question	Standard FM broadcast stations use a maximum bandwidth of
A	150 kHz
B	200 kHz
C	75 kHz
D	15 kH
Answer	B
Marks	1
CO mapped	2

Question	In FM modulation, when the modulation index increases, transmitted power is
A	Constant
B	Increased
C	Decreased
D	None of the above
Answer	A
Marks	1
CO mapped	2

Question	The number of significant sideband in FM depend upon
A	Frequency
B	Modulation index
C	Phase
D	Amplitude
Answer	B
Marks	1
CO mapped	2

Question	Amplitude of PM wave
A	Remains constant
B	Change in proportion to the modulating voltage.
C	Change in proportion to the modulating frequency.
D	Phase
Answer	A
Marks	1
CO mapped	2

Question Bank: Theory

Q.No.	Question	Marks	CO Mapped

1	Draw the block diagram of FM super heterodyne radio receiver. Explain working of each block mentioning the typical frequencies at different points.	8	CO2
2	Explanation the need of Pre-Emphasis and De-Emphasis with their respective frequency response in FM.	8	
3	Discuss the importance of Pre-emphasis and De-emphasis network in the performance of FM system.	8	
4	Explain FM detection using PLL.	8	
5	Explain with block diagram FM stereo receiver.	8	
6	Explain with block diagram two way FM radio receiver.	8	
7.	Describe working of slope detector and balanced slope detector.	8	

Oral Questions
(CO Mapped – CO2)

Q 1. Give the detection methods for FM
Q 2. Draw S-curve. Explain.
Q 3. Draw the diagram of balanced slope detector
Q 4. Draw the diagram of phase discriminator and ratio detector.
Q 5. What is amplitude limiter? Need of amplitude limiting in AM or FM. Why?
Q 6. Draw the TRF radio receiver.
Q 7. Draw the super heterodyne receiver.
Q 8. Explain the super heterodyne principle.
Q 9. Draw the waveform at each and every block of the receiver.
Q 10. Give the IF, FM and AM value.
Q 11. What are the selection criteria for IF?
Q 12. What is adjacent channel rejection? What is Image frequency rejection?
Q 13. Define sensitivity, selectivity and fidelity
Q 14. Give the methods of measurement and what is measured first.
Q 15. What is AFC, AGC and delayed AGC?
Q 16. Give the block diagram of FM communication receiver.
Q 17. Draw the graph of sensitivity, selectivity, and fidelity.
Q 18. What is meant by tracking?
Q 19. Why the oscillator is called Local oscillator in case of receiver?
Q 20. What are the other types of oscillators?
Q 21. What is the function of RF?
Q 22. Which range is responsible for sensitivity, and selectivity?
Q 23. What is meant by double conversion?
Q 24. What is the use of scquelch circuit?
Q 25. What is pilot carrier?
Q 26. What is ISB? Spectrum. BW. Diagram for ISB receiver.

MCQs

Question	The standard intermediate frequency used in super heterodyne FM receivers is

A	88KHz
B	455KHz
C	15KHz
D	10.7KHz
Answer	D
Marks	1
CO mapped	2

Question	Pre-emphasis is used to:
A	increase the signal to noise ratio for higher audio frequencies
B	increase the signal to noise ratio for lower audio frequencies
C	increase the signal to noise ratio for all audio frequencies
D	allow stereo audio to be carried by FM stations
Answer	A
Marks	1
CO mapped	2

Question	A high value of IF for a Super heterodyne receiver
A	Improve image frequency rejection ratio
B	Improves the selectivity
C	Improves the sensitivity
D	Improves the fidelity
Answer	A
Marks	2
CO mapped	2

Question	A occurrence of double spotting indicates.....
A	that the selectivity is too poor
B	That the IF is too high
C	That image frequency rejection capability of the receiver is inadequate
D	That the local oscillator frequency is less than incoming signal
Answer	C
Marks	2
CO mapped	2

Question	IF = 455KHz,radio reviver is tuned to 855 KHz, the local oscillator frequency is
A	455 KHz

B	1310 KHz
C	1500 KHz
D	1520 KHz
Answer	B
Marks	2
CO mapped	2

Question	What is the standard value of Intermediate frequency?
A	450KHz
B	455KHz
C	500KHz
D	150KHz
Answer	B
Marks	2
CO mapped	2

3.8 d. Unit No.- IV

Pre-requisites: -

- FT, its properties and FT of periodic signals

Objectives:-

- To introduce with the concept of Sampling theorem and pulse modulation techniques like PAM, PWM, PPM

Outcomes:- Explain the sampling theorem and various pulse modulation techniques.

PI Mapped:- 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.4

Lecture No.	Details of the Topic to be covered	References	CO Mapped
1	Need of analog to digital conversion, sampling theorem for low pass signal in time domain	**R2**	**CO3**
2	Nyquist criteria, Types of sampling- natural and flat top		
3	Pulse amplitude modulation, Channel bandwidth for PAM		
4	Pulse Width Modulation (PWM) and Pulse Position Modulation (PPM): Generation & Detection		
5	Concept of TDM		

6	Equalization, Signal Recovery through holding		

Question Bank: Theory

Q. No.	Question	Marks	CO Mapped
	Unit IV		
1.	Compare Digital Pulse Modulation Methods.	10	CO3
2	A 1KHz sine wave is sampled and transmitted using 12bit PCM and DM system. If 25 cycle of the signal are digitized find: i) Signaling rate ii) Bandwidth required iii) Total number of bits transmitted.	8	
3	Explain band limited and time limited signals.	10	
4	What is Nyquist criterion? State sampling theorem in time domain. Draw the spectrum showing aliasing and guard band.	8	
5	With the help of block diagram, explain transmitter and receiver of pulse code modulation.	16	
6	State and prove sampling theorem in time domain.	7	
7	With the help of waveforms explain how PWM and PPM can be generated.	6	
8	Give the circuit for flat top sampling. Explain its working.	6	
9	Explain the types of sampling with waveforms.	6	
10	With the help of neat diagram, explain PWM.	7	

Oral Questions
(CO Mapped – CO3)

Q 1. Explain band limited and time limited signals.
Q 2. What is Nyquist criterion?
Q 3. State sampling theorem in time domain.
Q 4. Draw the spectrum showing aliasing and guard band.
Q 5. Explain transmitter and receiver of pulse code modulation.
Q 6. With the help of waveforms explain how PWM and PPM can be generated.
Q 7. Give the circuit for natural sampling. Explain its working.
Q 8. Give the circuit for flat top sampling. Explain its working.
Q 9. Explain the types of sampling with waveforms.
Q 10. Explain Aperture effect.

3.8 e. Unit No.- V

Pre-requisites: -

- FT, its properties and FT of periodic signals

Objectives: -

- To impart pre-requisites of digital communication systems and explore digital representation techniques like PCM, DPCM, DM and ADM

Outcomes: - Explain the various Digital Modulation techniques. (PCM, DPCM, DM, ADM).

PI Mapped: - 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.4

Lecture No.	Details of the Topic to be covered	References	CO Mapped
1	Quantization of Signals: Quantization error, Uniform & Non-Uniform types of Quantization	**R1, R2, R3**	**CO4**
2	Mid-rise & Mid-tread Quantizer, Companding: A-law & μ-law		
3	Pulse Code Modulation system: Generation & Reconstruction		
4	Differential Pulse code modulation, Delta Modulation, Adaptive Delta Modulation		

Question Bank: Theory

Q. No.	Question	Marks	CO Mapped
	Unit V		
1.	Compare Digital Pulse Modulation Methods.	10	CO4
2	A 1KHz sine wave is sampled and transmitted using 12bit PCM and DM system. If 25 cycle of the signal are digitized find: i) Signaling rate ii) Bandwidth required iii) Total number of bits transmitted.	8	
3	Explain band limited and time limited signals.	10	
4	What is Nyquist criterion? State sampling theorem in time domain. Draw the spectrum showing aliasing and guard band.	8	
5	With the help of block diagram, explain transmitter and receiver of pulse code modulation.	16	
6	State and prove sampling theorem in time domain.	7	
7	With the help of waveforms explain how PWM and PPM can be generated.	6	
8	Give the circuit for flat top sampling. Explain its working.	6	
9	Explain the types of sampling with waveforms.	6	
10	With the help of neat diagram, explain PWM.	7	

Oral Questions
(CO Mapped – CO4)

Q 1.What is a quantization process?

Q 2.What is quantization error?
Q 3.What are types of quantization techniques?
Q 4. What is Companding?
Q 5.What is A-law and μ-law Companding?
Q 6. What is PCM?
Q 7. What Differential Pulse code modulation and its advantages and disadvantages?
Q 8.What is Delta Modulation and its advantages and disadvantages?
Q 9.What is Adaptive Delta Modulation and its advantages and disadvantages?
Q 10. Which modulation requires less bandwidth?

3.8 f. Unit No.- VI

Pre-requisites: -

- FT, its properties and FT of periodic signals

Objectives: -

- To explain the techniques of waveform coding, multiplexing and synchronization in baseband digital transmission

Outcomes: - Illustrate Describe the techniques of waveform coding, multiplexing and synchronization in baseband digital transmission.

PI Mapped: - 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.4

Lecture No.	Details of the Topic to be covered	References	CO Mapped
1	Line codes: Properties and spectrum	**R1, R2**	**CO5**
2	Digital Multiplexing and hierarchies: T1, AT&T, E1, CCITT		
3	Scrambling & Unscrambling, Synchronization: Carrier Synchronization, Bit Synchronization and Frame Synchronization		
4	Intersymbol Interference, Equalization		

Question Bank: Theory

Q. No.	Question	Marks	CO Mapped
	Unit VI		
1.	Compare Digital Pulse Modulation Methods.	10	CO5

2	A 1KHz sine wave is sampled and transmitted using 12bit PCM and DM system. If 25 cycle of the signal are digitized find: i) Signaling rate ii) Bandwidth required iii) Total number of bits transmitted.	8	
3	Explain band limited and time limited signals.	10	
4	What is Nyquist criterion? State sampling theorem in time domain. Draw the spectrum showing aliasing and guard band.	8	
5	With the help of block diagram, explain transmitter and receiver of pulse code modulation.	16	
6	State and prove sampling theorem in time domain.	7	
7	With the help of waveforms explain how PWM and PPM can be generated.	6	
8	Give the circuit for flat top sampling. Explain its working.	6	
9	Explain the types of sampling with waveforms.	6	
10	With the help of neat diagram, explain PWM.	7	

Oral Questions
(CO Mapped – CO5)

Q 1. What are lines codes?
Q 2. What is Scrambling and Descrambling?
Q 3. Explain Carrier Synchronization,
Q 4. Explain Bit Synchronization and Frame Synchronization.
Q 5. Explain Intersymbol Interference, Equalization.

3.9 List of Practicals

Course Objectives:

1. To demonstrate different modulation techniques. (Group A: 1, 2, 4, 5, 6, 7, 8).
2. To explain the sampling theorem and aliasing effect. (Group A: 3)
3. To illustrate different line coding techniques and their spectral analysis. (Group A: 9)
4. To simulate PCM, DM system, sampling of a signal, scrambling and descrambling operation using any simulation tool (Group B: 12, 13, 14).

Course Outcomes: -

At the end of the course students will be able to –

CO1: Illustrate different modulation techniques. (Group A: 1, 2, 4, 5, 6, 7, 8).
CO2: Verify the Sampling Theorem and aliasing effect. (Group A: 3)
CO3: Demonstrate different line coding techniques and their spectral analysis. (Group A: 9)
CO4: Simulate PCM, DM system, sampling of a signal, scrambling and descrambling operation using any simulation tool (Group B: 12, 13, 14).

List of Practicals:

Sr. No.	Name of the Experiment
Group A: Hardware Practicals	
1	AM Generation (DSB-FC): Calculation of modulation index by graphical method, Power of AM Wave for different modulating signal and Observe Spectrum.
2	Frequency modulator & demodulator using Varicap / Varactor Diode and NE 566 VCO, IC 565 (PLL based detection), calculation of modulation index & BW of FM.
3	Verification of Sampling Theorem, PAM Techniques, (Flat top & Natural sampling), reconstruction of original signal, Observe Aliasing Effect in frequency domain.
4	Generation and Detection of PWM using IC 555
5	Study of PCM
6	Study of Companded PCM
7	Study of DM: Generation and detection
8	Study of ADM: Generation and detection
9	Study of line codes (NRZ, RZ, POLAR RZ, BIPOLAR (AMI), MANCHESTER) & their Spectral analysis
Group B: Simulation Practicals [Any 3 to be performed]	
10	Simulation of T1/E1 system using suitable software.
11	Simulation program to study effect of ISI and noise in baseband communication system
12	Simulation program to calculate Signal to noise ratio for PCM system & DM system
13	Verify Sampling Theorem using simulation
14	Demonstrate Scrambling and descrambling operation either using hardware or any simulation tool.

Sr. No.	Name of the Practical	CO Mapped	PI Mapped
1	AM Generation (DSB-FC): Calculation of modulation index by graphical method, Power of AM Wave for different modulating signal and Observe Spectrum.	CO1	1.4.1, 2.1.2, 2.2.2, 2.2.4
2	Frequency modulator & demodulator using Varicap / Varactor Diode and NE 566 VCO, IC 565 (PLL based detection), calculation of modulation index & BW of FM.	CO1	
3	Verification of Sampling Theorem, PAM Techniques, (Flat top & Natural sampling), reconstruction of original signal, Observe Aliasing Effect in frequency domain.	CO2	
4	Generation and Detection of PWM using IC 555	CO1	
5	Study of PCM	CO1	
6	Study of Companded PCM	CO1	
7	Study of DM: Generation and detection	CO1	

8	Study of ADM: Generation and detection	CO1	
9	Study of line codes (NRZ, RZ, POLAR RZ, BIPOLAR (AMI), MANCHESTER) & their Spectral analysis	CO3	
10	Simulation program to study effect of ISI and noise in baseband communication system	CO4	2.4.2, 2.4.4, 5.1.2, 5.2.2
11	Simulation program to calculate Signal to noise ratio for PCM system & DM system	CO4	
12	Verify Sampling Theorem using simulation	CO4	
	AM Generation (DSB-FC): Calculation of modulation index by trapezoidal method, Power of AM Wave for different modulating signal.	CO1	1.4.1, 2.1.2, 2.2.2, 2.2.4

Experiment related questions

Q 1. How to measure modulation index using the AM experimental set up?
Q 2. What is the difference in waveform method and trapezoidal method?
Q 3. What is the formula for calculating modulation index using waveform and trapezoidal method?
Q 4. What is modulating signal and sampling signal frequency?
Q 5. How do observe aliasing effect?
Q 6. Which method is better, Natural sampling or flat top sampling? Why?
Q 7. How to measure frequency deviation, modulation index using the FM experimental set up?
Q 8. How does varactor modulator work?
Q 9. What is simulation?
Q 10. How to plot input signal waveform in Matlab?
Q 11. Which command is used to plot more than one graph in a plot?
Q 12. What is the function of stem command?
Q 13. How to study effect of ISI and noise in baseband communication system?
Q 14. What is the function of the eye pattern plot

4. Name of the Course: Object Oriented Programming

Weekly Work Load(in Hrs)	Lecture	Tutorial	Practical
	3	-	2

In-sem	Theory	Practical	Oral	Term-work	Total Marks	Credit
30	70	-	50		150	4

4.1 Syllabus

UNIT I: Foundation of Object Oriented Programming

Introduction to procedural, modular, object-oriented and generic programming techniques, Limitations of procedural programming, Need of object-oriented programming, fundamentals of object-oriented programming: objects, classes, data members, methods, messages, data encapsulation, data abstraction and information hiding, inheritance, polymorphism. Inline functions, Function overloading, call by value and call by reference, return by reference, functions with default arguments, this pointer, illustrative Simple C++ Programs. Dynamic initialization of variables, memory management operators, Member dereferencing operators, operator precedence, typecast operators, Scope resolution operators, arrays

Unit II: Classes & Objects

Defining class, Defining member functions, static data members, static member functions, private data members, public member functions, arrays of objects, objects as function arguments. Constructors and Destructors: types of constructors, handling of multiple constructors, destructors. (Complex Class & String Class).

UNIT III: Operator Overloading

Fundamentals of Operator Overloading, Restrictions on Operators Overloading, Operator Functions as Class Members vs. as Friend Functions, Overloading Unary Operators, Overloading Binary Operators, Overloading of operators using friend functions

UNIT IV: Inheritance & Polymorphism

Introduction to inheritance, base and derived classes, friend classes, types of inheritance, hybrid inheritance, member access control, static class, multiple inheritance, ambiguity, virtual base class, Introduction to polymorphism, pointers to objects, virtual functions, pure virtual functions, abstract base

class, Polymorphic class, virtual destructors, early and late binding, container classes, Contained classes, Singleton class.

UNIT V: Templates, Namespaces and Exception handling
Templates: Introduction, Function template and class template, function overloading vs. function templates Namespaces: Introduction, Rules of namespaces Exception handling: Introduction, basics of exception handling, exception handling mechanism, throwing and catching mechanism, specifying exceptions, Multiple Exceptions, Exceptions with arguments C++ streams, stream classes, unformatted I/O, formatted I/O and I/O manipulators.

UNIT VI: Working with files
Introduction, classes for file Stream Operations, opening and closing files, detecting End_Of_File (EOF), modes f File Opening, file pointers and manipulators, updating file, error handling during file operations.

4.2 Course Objectives

1. Explain the principles of object oriented programming for writing programs using C++.
2. Illustrate the concept of data encapsulation, data abstraction, constructor and destructor in C++.
3. Explain the concept of operator overloading using member and friend functions in C++.
4. Discuss the concept of inheritance and dynamic binding using C++.
5. Teach the templates, namespaces, exception and file handling concepts to write programs in C++

4.3 Course Outcomes

Upon successful completion of this course, students should be able to:

1. Describe the principles of object oriented programming for writing programs using C++. (Bloom's Level 1 : Remember) (Unit I)
2. Apply the concept of data encapsulation, data abstraction, constructor and destructor to write program in C.(Bloom's Level 3: Apply) (Unit II)
3. Demonstrate the concept of operator overloading using member and friend functions in C++. (Bloom's Level 3 : Apply) (Unit III)
4. Illustrate the concept of inheritance and dynamic binding using C++. (Bloom's Level 3 : Apply) (

Unit IV)

5. Apply templates, namespaces ,exception and file handling concepts to write programs in C++ (Bloom's Level 3 : Apply) (Unit V and VI).

4.4 Text Books:

1.EBalagurusamy, Programming with C++, Tata McGraw Hill, 3rd Edition.

2.Herbert Schildt, The complete reference C++, Tata McGraw Hill, 4th Editon

4.5 Reference Books:

1. Robert Lafore, "Object Oriented Programming in C++", Sams Publishing, 4th Edition.

2. Matt Weisfeld, "The Object-Oriented Thought Process", Pearson Education.

4.6 Reference Web Links/ Research Paper/ Referred Book other than Mention in Syllabus:

1. NPTEL Course "Programming in Java" https://nptel.ac.in/courses/106/105/106105191/

2. NPTEL Course "Programming in C++" https://nptel.ac.in/courses/106/105/106105151/

3. Bjarne Stroustrup, "A Tour of C++".

4.7 Teaching Plan

Sr. No.	Unit	Topics to be covered	Total Lecture Planned	CO Mapped
1	**Foundation of Object Oriented Programming**	Introduction to procedural, modular, object-oriented and generic programming techniques, Limitations of procedural programming, Need of object-oriented programming, fundamentals of object-oriented programming: objects, classes, data members, methods, messages, data encapsulation, data abstraction and information hiding, inheritance, polymorphism. Inline functions, Function overloading, call by value and call	**12**	CO1

		by reference, return by reference, functions with default arguments, this pointer, illustrative Simple C++ Programs. Dynamic initialization of variables, memory management operators, Member dereferencing operators, operator precedence, typecast operators, Scope resolution operators, arrays.		
2	**Classes & Objects**	Defining class, Defining member functions, static data members, static member functions, private data members, public member functions, arrays of objects, objects as function arguments. Constructors and Destructors: types of constructors, handling of multiple constructors, destructors. (Complex Class & String Class).	**6**	CO2
3	**Operator Overloading**	Fundamentals of Operator Overloading, Restrictions on Operators Overloading, Operator Functions as Class Members vs. as Friend Functions, Overloading Unary Operators, Overloading Binary Operators, Overloading of operators using friend functions	**6**	CO3
4	**Inheritance & Polymorphism**	Introduction to inheritance, base and derived classes, friend classes, types of inheritance, hybrid inheritance, member access control, static class, multiple inheritance, ambiguity, virtual base class, Introduction to polymorphism, pointers to objects, virtual functions, pure virtual functions, abstract base class, Polymorphic class, virtual destructors, early and late binding, container classes, Contained classes, Singleton class.	**6**	CO4
5	**Templates, Namespaces and Exception handling**	Templates: Introduction, Function template and class template, function overloading vs. function templates Namespaces: Introduction, Rules of namespaces Exception handling: Introduction, basics of exception handling, exception handling mechanism, throwing and catching mechanism, specifying exceptions, Multiple Exceptions, Exceptions with arguments C++ streams, stream classes, unformatted I/O, formatted I/O and I/O manipulators	**6**	CO5

6	**Working with files**	Introduction, classes for file Stream Operations, opening and closing files, detecting End_Of_File (EOF), modes f File Opening, file pointers and manipulators, updating file, error handling during file operations	**6**	CO5

4.8 Unit wise Lecture Plan

4.8 a. Unit No.-I

Pre-requisites: -

Basics of computer programming

Objectives: -

Explain the principles of object oriented programming for writing programs using C++.

Outcome: -

Describe the principles of object oriented programming for writing programs using C++. (Bloom's Level 1 : Remember)

Program Indicator(PI):-

2.1.2 Identify engineering systems, variables, and parameters to solve the problems

2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem

Lecture No.	Details of the Topic to be covered	References
1	Evolution of Programming Paradigms	T1,R1
2	Features of OOP	T1,R1
3	Features of OOP	T1,R1
4	Features of OOP	T1,R1
5	Moving from C to C++, Control statements in C++	T1,R1
6	Refrence Variable, dynamic initialization f variable	T1,R1
7	Scope resolution operators, and programs based on same	T1,R1
8	Control statement, function	T1,R1

9	Inline function	T1,R1
10	Call by reference	T1,R1
11	Function Overloading	T1,R1
12	Function default arguments, arrays	T1,R1

Question Bank: Theory

Theory Paper

CO Mapped: CO1

Q. 1	Describe the basic principle of OOp
Q. 2	Compare C & C++
Q. 3	Explain reference variable
Q. 4	What is called by reference, explain with example
Q. 5	Write a program in C++ to find out roots of quadratic equation
Q. 6	Write a program in C++ to find out Factorial of given number using recursive function
Q. 7	Explain the concept of inline function
Q. 8	Define the following terms relate to OO programming a)encapsulation b) data abstraction c) inheritance d) polymorphism e)abstract data type f)object classes
Q. 9	Write an object representation of student class
Q.10	List advantages & disadvantages of OOPs
Q.11	Explain function overloading

4.8 b. Unit No.-II

Objectives :-

Illustrate the concept of data encapsulation, data abstraction ,constructor and destructor in C++.

Outcomes:-

Apply the concept of data encapsulation , data abstraction ,constructor and destructor to write program in C++. (Bloom's Level 3: Apply)

Program Indicator(PI):-

2.1.2 Identify engineering systems, variables, and parameters to solve the problems

2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem

Lecture No.	Details of the Topic to be covered	References
1	Designing of class, creation of object, calling member function	T1 R1
2	Nesting member function, array inside a class, object array	T1 R1
3	Passing object as a member function argument	T1 R1
4	Returning object from a function	T1 R1
5	Constructor, types of constructor	T1 R1
6	Destructor and its importance	T1 R1

Question Bank: Theory

Theory Paper

CO Mapped: CO2

Q. 1	What is a constructor? Is it mandatory to use constructors in a class
Q. 2	What is a class? how does it accomplish data hiding?
Q. 3	What is the parameterize constructor?
Q. 4	How to define member function ?

Q. 5	Describe the importance of destructor

Q. 6	Write a class for student

Q. 7	Write a class for Stack

Q. 8	Write a class Queue

4.8 c. Unit No.-III

Objectives:-

Explain the concept of operator overloading using member and friend functions in C++.

Outcomes:-

Demonstrate the concept of operator overloading using member and friend functions in C++.(Bloom's Level 3 : Apply)

Program Indicator(PI):-

2.1.2 Identify engineering systems, variables, and parameters to solve the problems
2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2.2 Identify, assemble and evaluate information and resources.
2.2.3 Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions

Lecture No.	Details of the Topic to be covered	References
1	Principle of operator overloading, concept of unary and binary operators	T1 R1
2	Overloading unary operator	T1 R1
3	Binary operator overloading	T1 R1
4	Friend function concept	T1 R1
5	Overloading operators using friend function	T1 R1
6	Friend class concept and implementation	T1 R1

Question Bank: Theory

Theory Paper

CO Mapped : CO3

Q. 1	What is operator overloading ?

Q. 2	Why it is necessary to overload an operator ?

Q. 3	List out the operators that cannot be overloaded

Q. 4	When is the friend function necessary to overload an operator ? Explain with the help of suitable example

Q. 5	Create a class Float that contain one float data member. Overload all the four arithmetic operators so that they all can operate on the object of Float class.

4.8 d. Unit No.-IV

Objectives :-

Discuss the concept of inheritance and dynamic binding using C++.

Outcomes:-

Illustrate the concept of inheritance and dynamic binding using C++ (Bloom's Level 3 : Apply)

Program Indicator(PI):-

2.1.2 Identify engineering systems, variables, and parameters to solve the problems
2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem

Lecture No.	Details of the Topic to be covered	References
1	Introduction to inheritance, base and derived classes, friend classes, types of inheritance, hybrid inheritance, member access control	T1 R1

2	Static class, multiple inheritance, ambiguity, virtual base class,	T1 R1
3	Introduction to polymorphism, pointers to objects, virtual functions	T1 R1
4	Pure virtual functions, abstract base class, Polymorphic class	T1 R1
5	Virtual destructors, early and late binding	T1 R1
6	Container classes, Contained classes, Singleton class.	T1 R1

Question Bank: Theory

Theory Paper

CO Mapped: CO 4

Question No.	Question
Q1	Define Inheritance and explain different types of inheritance.
Q2	Write a short note with example on method overriding
Q3	Explain with the help of program use of 'this' operator
Q4	Write a C++ program to illustrate multiple inheritance
Q5	Write a short note on abstract class
Q6	Explain pointers to objects concept with an example in C++
Q7	Differentiate between early binding and Late binding
Q8	Explain virtual destructor with the help of program in c++

Q9	Differentiate between Compile time and Run time polymorphism.

4.8 e. Unit No.-V

Objectives:-

Teach the templates, namespaces ,exception and file handling concepts to write programs in C++

Outcomes:-

Apply templates, namespaces ,exception and file handling concepts to write programs in C++ (Bloom's Level 3 : Apply)

Program Indicator(PI):-

2.1.2 Identify engineering systems, variables, and parameters to solve the problems
2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2.2 Identify, assemble and evaluate information and resources.

Lecture No.	Details of the Topic to be covered	References
1	Introduction, Function template	T1 R1
2	Class template, function overloading vs. function templates	T1 R1
3	Introduction, Rules of namespaces	T1 R1
4	Introduction, basics of exception handling, exception handling mechanism	T1 R1
5	Throwing and catching mechanism, specifying exceptions, Multiple Exceptions	T1 R1
6	Exceptions with arguments C++ streams, stream classes, unformatted I/O, formatted I/O and I/O manipulators.	T1 R1

Question Bank: Theory

Theory Paper

CO Mapped: CO5

Question No.	Question
Q1	What is concept of function template. Explain with the help of example
Q2	Explain the concept of exception handling mechanism in detail
Q3	Write a short note on try, throw and catch.
Q4	Explain the concept of class template with suitable example
Q5	Write a C++ program to calculate factorial of a number. Use exception handling
Q6	Write a program in C++ to perform operations on stack. Implement stack of integers and a stack of characters. Use class template.
Q7	Explain use of namespace with the help of program.
Q8	Write a short note on namespaces
Q9	Implement namespace for variables and functions.

4.8 f. Unit No.-VI

Objectives: -

Teach the templates, namespaces, exception and file handling concepts to write programs in C++

Outcomes: -

Apply templates, namespaces, exception and file handling concepts to write programs in C++ (Bloom's Level 3 : Apply)

Program Indicator(PI):-

2.1.2 Identify engineering systems, variables, and parameters to solve the problems
2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2.2 Identify, assemble and evaluate information and resources.

Lecture No.	Details of the Topic to be covered	References

1	Introduction, classes for file Stream Operations	T1 R1
2	Opening and closing files, detecting End_Of_File (EOF)	T1 R1
3	Modes f File Opening,	T1 R1
4	File pointers and manipulators	T1 R1
5 and 6	Updating file, error handling during file operations	T1 R1

Question Bank: Theory

Theory Paper

CO Mapped: CO5

Question No.	Question
Q1	Explain the classes associated with file handling
Q2	Expalin how to read and write a sentence in a file with the help of program
Q3	Explain different file opening modes in detail
Q4	Explain I/O manipulators.
Q5	Explain file open operation and various modes of file opening,
Q6	What are various file handling error flags along with their purpose? Explain
Q7	Explain get pointer and put pointer.
Q8	Write a short note on file pointer and explain the use of seek and tell functions.
Q9	Write syntax of seek and tell functions.
Q10	How can we detect end of file.

4.9 List of Practical

Lab Course Objectives

- To Illustrate basic C++ programming language.
- To Discuss classes, objects and operator overloading using C++.
- To Explain inheritance and its type using C++.
- To Illustrate use of namespace , exception and file handling using C++.

Lab Course Outcomes

At the end of the course student will be able to -

Write C++ programme for the given problem using function and reference variable.
(Bloom's Level 3 : Apply) (Lab 1)

Demonstrate classes, objects and operator overloading using C++.
(Bloom's Level 3 : Apply) (Lab 2-7)

Execute programming skills using inheritance in C++.
(Bloom's Level 3 : Apply) (Lab 8)

Demonstrate use of namespace , exception and file handling using C++.
(Bloom's Level 3 : Apply) (Lab 9-11)

Program Indicator(PI)-

2.1.2 Identify engineering systems, variables, and parameters to solve the problems
2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.4.2 Produce and validate results through skilful use of contemporary engineering tools and models
2.4.3 Identify sources of error in the solution process, and limitations of the solution.
5.1.1 Identify modern engineering tools such as computer-aided drafting, modeling and analysis; techniques and resources for engineering activities
5.1.2 Create/adapt/modify/extend tools and techniques to solve engineering problems
5.2.2 Demonstrate proficiency in using discipline-specific tool

List of Practical

Sr.No.	Name of the Practical	CO Mapped
1	Write a program in C++ to sort the numbers in an array using separate functions for read, display, sort and swap. The objective of this assignment is to learn the concepts of input, output, functions, call by reference in C++.	CO1

2	Write a program in C++ to perform following operations on complex numbers Add, Subtract, Multiply, Divide, Complex conjugate. Design the class for complex number representation and the operations to be performed. The objective of this assignment is to learn the concepts classes and objects.	CO2
3	Write a program in C++ to implement Stack. Design the class for stack and the operations to be performed on stack. Use Constructors and destructors. The objective of this assignment is to learn the concepts classes and objects, constructors and destructors.	CO2
4	Write a program in C++ to overload unary operators for complex class.	CO2
5	Write a program in C++ to perform following operations on complex numbers Add, Subtract, Multiply, Divide. Use operator overloading for these operations. The objective of this assignment is to learn the concepts operator overloading.	CO2
6	Write a program in C++ to implement string class. Write constructors, destructor, Accepts function and Display function.	CO2
7	Write a program in C++ to Read and Display the information of Employee Using Multiple Inheritance. Use Basic Info and Department Info as a base classes of Employee class.	CO2
8	Write a C++ program which use try and catch for exception handling.	CO3
9	Write a C++ program which to implement class and function template.	CO4
10	Write a C++ program which to demonstrate use of namespace in the program.	CO4
11	Write a C++ program which copies the contents of one file to another.	CO4
12	Write a program for Handling date and time using library function	CO1

Oral Question Bank

Sr. No.	Questions	CO Mapped
1.	Explain basic concepts of object oriented programming. OR Explain oop paradigm concepts. (Note : explain encapsulation,polymorphism,abstraction,inheritance,containment,etc)	CO1
2.	What are the drawbacks of procedure oriented programming?	CO1
3.	How to use ternary operator?	CO1
4	List few tokens from C++	CO1
5	Write down difference between C and C++ Programming	CO1
6	How OOP Platform ensure reusability and extensibility of modules	CO1
7	How to represent real life entities of problems in system design	CO1
8	How OO programming ensures system design with open interface	CO1
9	List out different programming styles	CO1
10	What is object	CO1
11	Define Class	CO1
12	Explain dynamic binding	CO1
13	List of difference between message driven call and function driven call	CO1
14	List out advantages and disadvantages of OOP	CO1
15	Draw pictorial representation of student class	CO3
16	In C++ why main function is called as driver function	CO2

17	In the following statement
	for(i=0;i<5;++i)
	{
	-------- 	
	-------- 	
	-------- 	
		CO2

	} i=6 Does this program contains error.Justify	
18	What are the different types of access specifier supported by C++	CO2
19	What are the differences between static binding and late binding	CO4
20	What are the different data types supported by C++	CO1
21	What are keywords? List keywords specific to C++	CO1
22	What is an expression? Is it different than statement?	CO1

23	What is the effect of following statement if i=1 & j=4
	
	a. i++
	b. j= j++;
	c. j=++j;
	d. i + ++j;
	e. i= i++ + ++j
		CO1

24	Explain reference variable how it differ from natural variable	CO1
25	What is an inline function	CO2
26	Which operator we cannot overload in C++	CO3
27	What is a static variable	CO2
28	What is static function	CO2
29	What is data hiding	CO1
30	What are constructor and destructors. Explain how they differ normal functions.	CO2
31	What is copy constructors	CO2
32	List types of constructors	CO2
33	State difference between private access specifier and protected access specifier	CO2
34	What are the different types of inheritance	CO4
35	Can base class access derived class	CO4

36	What are the differences between inheritances with public and private visibility mode	CO4
37	Explain the sequence of execution of constructor and destructor in inherited class	CO4
38	What are virtual classes	CO4
39	What are abstract classes	CO4
40	Describe different methods of realizing polymorphism in C++	CO4
41	What are pure virtual functions	CO4
55	What is type casting? Explain with suitable example	CO2
56	What are the primitive data types supported by C++	CO1
57	Write a program in C++ To find sum of following harmonic series, 1+(1/2)+(1/3)+…+(1/n) Value of n must be taken from user	CO1
58	Write a program to read the price of an item in decimal form(eg. 55.30) and print the output in paise (eg. 5530 paise)	CO1
59	Write a program to convert temperature from Fahrenheit to Celcius Display the result	CO1
60	How method is defined? Explain with suitable example	CO2
61	When we declare member of a class as static	CO2
62	Compare overriding and overloading methods	CO4
63	what is virtual function	CO4
64	What is abstract class	CO4
65	Declare a pointer to object	CO4
66	Significance of this pointer	CO4
67	Define polymorphism	CO4
68	What is meant by early binding	CO4

69	What is meant by late binding	CO4
70	Give an example of polymorphism	CO4
71	Why you need function or class template	CO5
72	write syntax of function template	CO5
73	Write syntax of class template	CO5
74	Explain keyword namespace	CO5
75	why is namespace used in program	CO5
76	explain using namespace std statement	CO5
77	What is meant by exception handling	CO5
78	Define terms Try, Throw and catch	CO5
79	Can there be more than catch blocks in a program?	CO5
80	Write syntax of try and catch block	CO5
81	List different circumstances when exceptions can occur	CO5
82	What is difference between overloading a function and overloading a template function	CO5
83	List classes associated with file handling	CO5
84	Explain fopen and fclose methods in file handling	CO5
85	List different file opening modes in c++	CO5
86	What are the different flags associated with error in file handling	CO5
87	What is file pointer.	CO5
88	What are the functions associated with file pointer.	CO5
89	Write syntax of seekg() and tellg()	CO5
90	Explain functions getline and outline used in c++	CO5