CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET305	SIGNALS AND SYSTEMS	PCC	3	1	0	4

Preamble : This course introduces the concept of signals and systems. The time domain and frequency domain representation, operations and analysis of both the continuous time and discrete time systems are discussed. The application of Fourier analysis, Laplace Transform and Z-Transforms are included. Stability analysis of continuous time systems and discrete time systems are also introduced.

Prerequisite : **Basics of Circuits and Networks**

Course Outcomes : After the completion of the course the student will be able to:

CO 1	Explain the basic operations on signals and systems.
CO 2	Apply Fourier Series and Fourier Transform concepts for continuous time signals.
CO 3	Analyse the continuous time systems with Laplace Transform.
CO 4	Analyse the discrete time system using Z Transform.
CO 5	Apply Fourier Series and Fourier Transform concepts for Discrete time domain.
CO 6	Describe the concept of stability of continuous time systems and sampled data systems.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	-	-	2	-	-	-	-	-	-	1
CO 2	3	3	3	-	-	-	-	-	-	-	-	1
CO 3	3	3	3	-	2	-	-	-	-	-	-	2
CO 4	3	3	3	-	2	-	-	-	-	-	-	2
CO 5	3	3	3	-	-	-	-	-	-	-	-	2
CO 6	3	3	-	-	2	-	-	-	-	-	-	1

Assessment Pattern:

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	03 Hrs

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	20
Understand (K2)	10	10	20
Apply (K3)	30	30	60
Analyse (K4)			
Evaluate (K5)			
Create (K6)			

End Semester Examination Pattern : There will be two parts; Part A and Part B. **Part A** contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions.

Part B contains 2 questions from each module of which student should answer any one. Each question carries 14 marks and can have maximum 2 sub-divisions.

Course Level Assessment Questions :

Course Outcome 1 (CO1)

1. What are the standard test signals?
2. Problems related to various operations of signals.
3. Problems related to representation of systems in differential equation form.
4. Explain any three differences between linear and nonlinear systems.

Course Outcome 2 (CO2):

1. Problems related to Fourier series of continuous signals.
2. Problems related to Fourier transform of continuous systems.
3. Obtain the frequency response of the given system.

Course Outcome 3(CO3):

1. Derivations of transfer function of a given electrical system to comment on the system behaviour.
2. Problems related to analogous systems.
3. Problems related to block diagram reduction.

Course Outcome 4 (CO4):

1. Problems related ZIT.
2. Problems related to ZTF from difference equation form.
3. Problems related to block diagram development of ZTF of the given sampled system.

Course Outcome 5 (CO5):

1. Problems related to Discrete Fourier series of DT signals.
2. Problems related to Discrete time Fourier transform of DT signals
3. Obtain the frequency response of the given DT system.

Course Outcome 6 (CO6):

1. Problems related to the stability analysis of given continuous time systems using Routh criterion.
2. Problems related to stability analysis of DT systems.
3. Differentiate between asymptotic stability and BIBO stability?

Model Question Paper PAGES: 3

QPCODE:

Reg. No:___________

Name:_____________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIFTH SEMESTER B.TECH DEGREE EXAMINATION
MONTH & YEAR

Course Code**: EET305**

Course Name: **SIGNALS AND SYSTEMS**

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1 Define unit ramp signal r(t). Sketch the signal r(-t+2).

2 Explain any two peculiar characteristics of nonlinear systems.

3 What are the conditions for the existence of Fourier transform?

4 Why do you use analogous systems? Explain with a suitable example.

5 Determine the unit impulse response for the system with $T(s) = \frac{2}{(s^2 + s - 12)}$

6 Explain the concept of positive real functions.

7 Explain the significance of ZOH circuit in signal reconstruction.

8 Write three properties of discrete convolution.

9 State and prove time reversal property of discrete time Fourier series.

10 Find the Fourier transform of x(n)= n u(n).

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11 a) Check whether the following system is static, causal, linear and time invariant: $y(t) = |x(t)|$ **(8)**

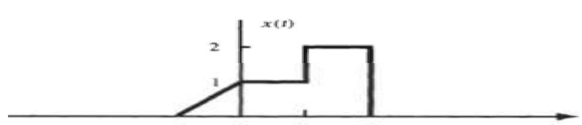
b) Find the convolution of $x_1(t)$ and $x_2(t)$ for the following signals: $x_1(t) = e^{-at}u(t); x_2(t) = e^{-bt}u(t)$ **(6)**

12 a) With suitable examples differentiate between:

i. Odd and even signals,

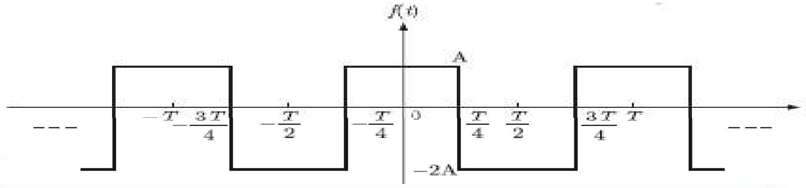
ii. Causal and non causal systems. **(7)**

b) The signal x(t) is given below. Plot x(t-1)+ x(-t+2) **(7)**



Module 2

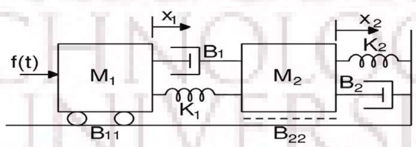
13 a) Find the trigonometric Fourier series for the periodic signal f(t).



(9)

b) State and prove time shifting property of Fourier transform. **(5)**

14 a) Derive the transfer function $X_2(s)/F(s)$ for the mechanical



(7)

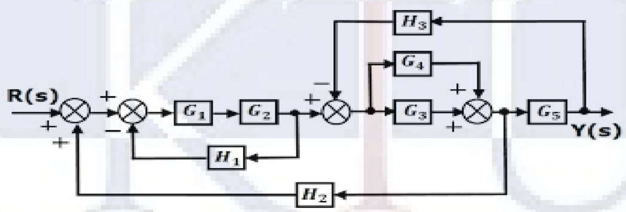
b) A system is described by the following differential equation:

$$\frac{d^2y(t)}{dt^2}+7\frac{dy(t)}{dt}+12y(t)=x(t);\; y(0^-)=-2,\; \frac{dy}{dt}(0^-)=0$$

Determine the response of the system to a unit step applied at t=0. **(7)**

Module 3

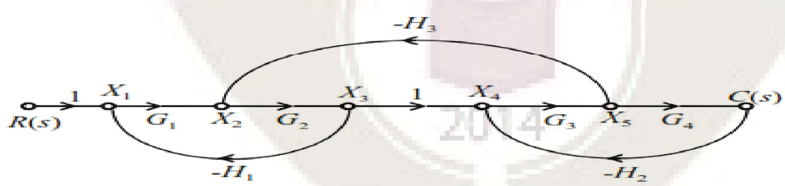
15 a) Determine the overall transfer function Y(s)/R(s) using block diagram reduction.



(8)

b) Check stability of the system represented by the following characteristic equation, using Routh stability criterion: $3s^4+10s^3+5s^2+5s+2=0$ **(6)**

16 a) Determine the transfer function of the system represented by the signal flow graph using Mason's gain formula.



(9)

b) How frequency response can be obtained from poles and zeros? **(5)**

Module 4

17 a) Determine the convolution sum of two sequences x(n)={1,4,3,2} and h(n)={1,3,2,1} using graphical method. **(8)**

b) Determine the z-transform of $x(n)=(1/2)^n u(-n)$. **(6)**

18 a) Explain the aliasing effect in sampled data systems. **(5)**

b) Determine the inverse z-transform of the following functions:

$$i) X(z)=\frac{2z^{-1}}{(1-\frac{1}{4}z^{-1})^2};\; ROC: |z|>\frac{1}{4}, and, ii) F(z)=\frac{3z^{-1}}{(1-z^{-1})(1-2z^{-1})};\; ROC: |z|>2$$ **(9)**

Module 5

19 a) Determine the complete solution of the difference equation: y (n) + 2y(n-1) + y(n-2) = x (n) + x(n-1) for the input x(n) = (0.5^n) u(n), initial conditions y(-1) = y(-2) = 1? **(9)**

b) Find the Fourier series coefficients for x(n)=cos(πn/4) **(5)**

20 a) i) Obtain the direct form-I realization for the system described by the difference equation: $y(n)-\frac{5}{6}y(n-1)+\frac{1}{6}y(n-2)=2x(n)$

ii) Also determine the impulse response h(n) for the above system. **(4+5)**

b) Check stability of the system described by the following characteristic equation, using Jury's test: $z^3-0.2z^2-0.25z+0.05=0$ **(5)**

Syllabus

Module 1

Introduction to Signals and Systems (9 hours):

Classification of signals: Elementary signals- Basic operations on continuous time and discrete time signals

Concept of system: Classification of systems- Properties of systems- Time invariance- Linearity -Causality – Memory- Stability-Convolution Integral- Impulse response

Representation of LTI systems: Differential equation representations of LTI systems

Basics of Non linear systems- types and properties

Introduction to random signals and processes (concepts only)

Module 2

Fourier Analysis and Laplace Transform Analysis (10 hours):

Fourier analysis of continuous time signals: Fourier Series- Harmonic analysis of common signals

Fourier transform: Existence- Properties of Continuous time Fourier transform- Energy spectral density and power spectral density

Concept of Frequency response

Laplace transform analysis of system transfer function: Relation between the transfer function and differential equation- Transfer function of LTI systems- Electrical, translational and rotational mechanical systems- Force voltage, Force current and Torque Voltage analogy

Module 3

System Models and Response (8 hours):

Block diagram representation - block diagram reduction

Signal flow graph - Mason's gain formula

Type and Order of the systems- Characteristic equation

Determining the time domain and frequency response from poles and zeros

Concepts of Positive real functions and Hurwitz polynomial- Routh stability criterion.

Simulation based analysis: Introduction to simulation tools like MATLAB/ SCILAB or equivalent for mathematical and signal operations (Demo/Assignment only)

Module 4

Sampled Data Systems and Z-Transform (9 hours):

Sampling process-Impulse train sampling-sampling theorem- Aliasing effect
Zero order and First order hold circuits- Signal reconstruction
Discrete convolution and its properties
Z Transform: Region of convergence- Properties of Z Transform
Inverse ZT: Methods

Module 5

Analysis of Sampled Data Systems (9 hours):

Difference equation representations of LTI systems - Analysis of difference equation of LTI systems- Z Transfer function- Delay operator and block diagram representation- Direct form, cascade and parallel representations of 2nd order systems
Stability of sampled data system: Basic idea on stability- Jury's test- Use of bilinear transformation
Discrete Fourier series: Fourier representation of discrete time signals - Discrete Fourier series– properties.
Discrete Time Fourier Transform: Properties- Frequency response of simple DT systems

Text Books

1. Oppenheim A.V., Willsky A.S. & Nawab S.H., Signals and Systems, 2/e, Prentice Hall
2. Nagrarth I. J, Saran S. N and Ranjan R, Signals and Systems, 2/e, Tata McGraw Hill
3. Haykin S. & Veen B.V., Signals & Systems, 2/e, John Wiley
4. Nise N. S., Control Systems Engineering, 6/e, Wiley Eastern
5. Nagarath I. J. and Gopal M., Control System Engineering, 5/e, New Age Publishers

Reference Books

1. Bracewell R.N., Fourier Transform & Its Applications, McGraw Hill
2. Farooq Husain, Signals and Systems, Umesh publications.
3. Papoulis A., Fourier Integral & Its Applications, McGraw Hill
4. Taylor F.J., Principles of Signals & Systems, McGraw Hill

Course Contents and Lecture Schedule:

Module	Topic coverage	No. of Lectures
1	**Introduction to Signals and Systems (9 hours)**	
1.1	Classification of signals - Elementary signals- Basic operations on continuous time and discrete time signals	2
1.2	Concept of systems - Classification of systems- Properties of systems - Time invariance- Linearity -Causality – Memory- Stability.	2
1.3	Convolution Integral- Impulse response-	1
1.4	Representation of LTI systems - Differential equation representations of LTI systems	2
1.5	Basics of Non linear systems- types and properties Introduction to random signals and processes (concepts only)	2
2	**Fourier Analysis and Laplace Transform Analysis (10 hours)**	

2.1	Fourier Analysis of continuous time signals: Fourier Series- Harmonic analysis of common signals	2
2.2	Fourier transform: Existence- Properties of Continuous time Fourier transform- Energy spectral density and power spectral density	2
2.3	Concept of Frequency response- Frequency response of simple LTI systems.	2
2.4	Laplace transform analysis of system transfer function: Relation between the transfer function and differential equation	1
2.5	Transfer function of LTI systems: Electrical, Translational and rotational Mechanical systems	2
2.6	Force Voltage, Force Current and Torque Voltage analogy	1
3	**System Models and Response (8 hours)**	
3.1	Block diagram representation - block diagram reduction	2
3.2	Signal flow graph - Mason's gain formula	1
3.3	Type and Order of the systems- Characteristic equation.	1
3.4	Determining the time domain and frequency response from poles and zeros.	2
3.5	Concepts of Positive real functions and Hurwitz polynomial- Basic idea on Stability- Routh stability criterion	2
3.6	*Simulation based analysis: Introduction to simulation tools like MATLAB/ SCILAB or equivalent simulation software and tool boxes for various mathematical operations (Demo/Assignment only)*	
4	**Sampled Data Systems and Z-Transform (9 hours)**	
4.1	Sampling process-Impulse train sampling-sampling theorem- Aliasing effect	2
4.2	Zero order and First order hold circuits- Signal reconstruction-	2
4.3	Discrete convolution and its properties	1
4.4	Z Transform: Region of convergence- Properties of Z Transform	2
4.5	Inverse ZT: Methods	2
5	**Analysis of Sampled Data Systems (9 hours)**	
5.1	Difference equation representations of LTI systems - Analysis of difference equation of LTI systems- Z Transfer function	2
5.2	Delay operator and block diagram representation- Direct form, cascade and parallel representations of 2nd order systems.	2
5.3	Stability of sampled data system: Basic idea on Stability- Jury's test- Use of bilinear transformation.	2
5.4	Discrete Fourier Series: Fourier representation of discrete time signals - Discrete Fourier series– properties	2
5.5	Discrete Time Fourier Transform: properties- Frequency response of simple DT systems	1