GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Subject Code : BE03000261

Subject Name : Signals and Systems

WEF Academic Year:	2024-25
Semester:	3
Category of the Course:	Basic Science Course

Prerequisite :	Basic knowledge of integration, differentiation and complex numbers.
Rationale :	This course will provide the students (i) understanding of the mathematical description of continuous and discrete time signals and systems, (ii) to classify signals into different categories, (iii) to analyze Linear Time Invariant (LTI) systems in time and transform domains, and (iv) to build foundation for understanding of courses such as control system and signal processing.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level*
01	Classify various types of signals and systems, and perform various operations on them.	UN
02	Analyze CT and DT systems in time domain using convolution.	UN/AP
03	Use transforms for the analysis of signals and systems in continuous and discrete time domain	AP
04	Analyze DT systems using z-transforms.	AN

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Classification of Signals and Systems** Introduction to signals and systems: Continuous Time (CT) and Discrete Time (DT) signals, Periodic and Aperiodic signals, Even and Odd signals, Energy and Power signals, Deterministic and Random signals. Standard signals: Impulse, Step, Ramp, Pulse, Real and Complex exponential and Sinusoidal. Classification of systems: CT and DT, Memory and Memory less, Casual and Non-casual, Inverse, Stable and Unstable, Time-variant and Time-invariant, Linear and Nonlinear systems.	5	11
2	**Linear Time Invariant(LTI) systems** Discrete time LTI systems, Continuous time LTI systems, Properties of LTI systems.	5	15
3	**Fourier Series Representation of Periodic Signals** Introduction, A historical perspective, The response of LTI systems to complex exponentials, Fourier series representation of continuous time periodic signals and discrete time periodic signals, Properties of CT Fourier series and DT Fourier series, Fourier series and LTI systems, Filtering, Examples of CT filters described by differential equations.	9	21
4	**The Continuous Time Fourier Transform (CTFT)** Introduction, Representation of aperiodic signals – CTFT, Fourier transform for periodicsignals, Properties of CTFT, Convolution property.	7	15
5	**The Discrete Time Fourier Transform (DTFT)** Introduction, Representation of aperiodic signals, Fourier transform for periodic signals, Properties of DTFT, Convolution property.	7	15
6	**The Laplace Transform (Review)** Introduction, Definition, Region of convergence (ROC), Inverse Laplace transform, Properties of the Laplace transform, Analysis and characterization of LTI systems using the Laplace transform: Causality, Stability.	5	8

7	**The Z-Transform** Introduction, Definition, Region of convergence (ROC), Inverse z-transform, Geometric evaluation of the Fourier transform from the pole-zero plot of First order and Second order systems, Properties of the Z-transform, Analysis and characterization of LTI systems using Z-transform, System function algebra and block diagram representations.	**7**	**15**
	Total	**45**	**100**

Reference Book:

1. Signals & Systems, Alan V. Oppenheim, Alan S. Willsky and S. Hamid Nawab, Second Edition, PHI publications.
2. Signals and Sytems, Simon Haykin and Barry Van Veen, John Wiley and Sons, Second Edition, 2004.
3. Signal and Linear System Analysis, Gordon E. Carlson, Allied Publishers Limited.
4. Signals and Systems, A Anandkumar, PHI publications.
5. Signals and Systems, S Poornachandra and B Sasikala, McGraw Hill Education (India) Pvt. Ltd.

Suggested Course Practical List:

Write the programs in MATLAB/Scilab

1. Generate an impulse, step, and square waveforms in continuous and discrete domain.
2. Generate sinusoidal waveforms of different frequencies in continuous and discrete domain. Understand the difference between CT and DT waveforms.
3. Generate growing exponential, decaying exponential, and exponentially damped sinusoidal signals.
4. Find the discrete/continuous convolution between two sequences/signals. Verify the commutative, distributive and associative properties of convolution.
5. Perform folding, shifting and scaling on a given signal x(t) to obtain a signal of the form x(at+b).
6. Find the output of the system with given input (e.g. x[n]=2 {u[n+2] – u[n-12]}) and given impulse response (e.g. h[n]= 0.9n {u[n+2] – u[n-12] }.
7. Obtain the impulse response h[n] of the systems.
8. Compute FT and DTFT of the continuous time signals and discrete time sequences.
9. Find the partial fraction expansion of the given z-transform.
10. Given an LTI system with transfer function, plot its (i) pole-zero plot in the z-plane and (ii) frequency response.
11. Convert pole-zero gain form of z-transform to second order systems.

List of Laboratory/Learning Resources Required:

1. MIT open courseware, Signals and Systems, Prof. Dennis Freeman https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-003-signals-and-systems-fall-2011/lecture-videos/
2. NPTEL lectures on signals and systems.
3. Common Lab Manual (DTE)
4. Virtual Laboratory (vLab.co.in)

- **List of suggested activities for Problem Based Learning:**

Sr. No.	Name of the activity	No. of hours per activity	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding-based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point	Duration = 6 h	Based on poster/chart

	preparation on technical topics		preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software
15	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
16	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:

1. All the suggested activity should be related to the subject.
2. Subject coordinator shall identify activities from above list as per the subject needs, they also declare list of activities wise hours, evaluation scheme and rubrics to students at the start of semester.
3. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
4. All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
5. Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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