# GUJARAT TECHNOLOGICAL UNIVERSITY

**Program Name: Bachelor of Engineering**

**Level: UG**

**Subject Code: BE03000171**

**Subject Name: Signals & Systems**

| | |
|---|---|
| WEF Academic Year : | 2024-25 |
| Semester : | 3 |
| Category of the Course : | PCC |

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|---|---|
| **Prerequisite :** | Differential equations and difference equations, Laplace Transform, Electrical circuits and networks |
| **Rationale :** | The course will provide strong foundation on signals and systems which will be useful for creating foundation of communication and signal processing. The students will learn basic continuous time and discrete time signals and systems. Student will understand application of various transforms for analysis of signals and systems both continuous time and discrete time. Students will also explore effect of sampling on spectrum of signal. |

**Course Outcome :**

After Completion of the Course, Student will able to :

| No | Course Outcomes | RBT Level* |
|---|---|---|
| 01 | Understand about various types of signals, classify them, analyze them, and perform various operations on them. | RM,UN |
| 02 | Understand about various types of systems, classify them, analyze them and understand their response behavior. | RM,UN |
| 03 | Appreciate use of transforms in analysis of signals and system. | AP |
| 04 | Carry simulation on signals and systems for observing effects of applying various properties and operations. | AN |
| 05 | Create strong foundation of communication and signal processing to be studied in the subsequent semester | AP,AN,CR |

**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 | TW/SL | TH | | ESE (E) | PA (M) | PA/ (I) | TW/ SL (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

**Course Content :**

| Sr. No. | Course Content | No. of Hours | % of Weightage |
|---|---|---|---|
| 1 | **Introduction to Signals & Systems:** Basic definitions of signals and systems, Basic elementary signals, Classification of signals and systems. Signal operations and properties. Basic continuous time signals, Basic system properties, Case study of different signals | 12 | 27 |
| 2 | **Behaviour of Continuous time (CT)& Discrete Time(DT) Linear Time Invariant (LTI) System:** Impulse response characterization and convolution for CT- LTI and DT-LTI systems, Properties of LTI systems, LTI systems characterized by Differential and difference equations | 8 | 18 |
| 3 | **Introduction to Fourier Series, Fourier Transform:** Fourier Series Representation of periodic Signals, Fourier series, Waveform | 12 | 27 |
| | Symmetries, Calculation of Fourier Coefficients, Frequency spectrum of aperiodic signals, Fourier Transform, Relation between Laplace Transform and Fourier Transform. Properties of Continuous Time Fourier transform. System Analysis using Fourier Transform. | | |
| 4 | **Sampling & Reconstruction:** Representation of digital signals, The Sampling Theorem, Sampling with a zero order hold, Reconstruction of a signal from its samples using interpolation, Aliasing and its effects. | 5 | 10 |
| 5 | **Z Transform:** The z-Transform, Convergence of z-Transform, , Properties of z-Transform, Inverse z-Transform | 8 | 18 |
| | | | |
| | **Total** | **45** | **100** |

**Reference Book :**

1. Signal and Systems By Anand Kumar, 3rd Edition, PHI
2. Signals and Systems by Alan V. Oppenheim, Alan S. Wilsky and Nawab, Prentice Hall
3. Signals and Systems by K. Gopalan, Cengage Learning (India Edition)
4. Signals and Systems by Michal J. Roberts and Govind Sharma, Tata Mc-Graw Hill Publications
5. Signals and Systems by Simon Haykin and Bary Van Veen, Wiley-India Publications
6. Linear Systems and Signals by B.P.Lathi, Oxford University Press
7. Signal, Systems and Transforms by Charles L. Philips, J. M. Parr and E. A. Riskin, Pearson Education
8. Digital Signal Processing Fundamentals and Applications by Li Tan, Elsevier, Academic Press

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

**Suggested Course Practical List :**

1. Generations and capturing various continuous time signals from sensors.
2. Generation and capturing of discrete time signals and plot them.
3. Discretization using different sampling rate and observing aliasing effect.
4. Observing the effects of lower sampling rate and higher sampling rate on CT signal.
5. Performing various operations on the signal using circuits and computational software.
6. Using digital circuit building block to perform operations on signals.
7. Simulation of continuous time LTI system.
8. Simulation of discrete time LTI systems.
9. Obtaining impulse response of the systems.
10. Computing FT and DTFT of the CT signals and DT sequences.

**List of Laboratory/Learning Resources Required:**

**Major Equipments**:

Computers, analog circuit blocks, digital circuit blocks, signal generators, digital storage oscilloscope and spectrum analyser

**List of Open Source Software/learning website:**

1. SEQUEL
2. SCILAB
3. NPTEL Videos
4. MIT open course ware website
5. MATLAB

- **Activities suggested under Self-learning/Team Work:**

| Sl. No. | Name of the activity | No. of hours | Evaluation Criteria |
|---|---|---|---|
| 1. | Industry/Research laboratory visit | Visit = 5h, Report preparation = 5h<br>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<br>Report preparation = 5h<br>Total = 10h | Report /presentation based on the video learning outcomes. |
| 3. | Assignment writing. | 5 assignments of 2h each. | Based on the assignment |

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|---|---|---|---|
| | Numerical based assignment is preferable. | Total = 10h | 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<br>Report preparation = 5h<br>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 preparation on technical topics | Duration = 6 h | Based on poster/chart preparation and presentation skills |
| 10 | Working/non-working model on technical topics | Working = 12 h<br>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<br><br>Problem identification and tentative solution = 10 h<br>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<br>Report preparation = 5h<br>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 |

Note:

- All the suggested activity should be related to the subject.
- The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.

- Rubrics for the evaluation can be prepared by the faculty.
- 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.
- 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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