SAMPLE COURSE PLAN

Course Title	Digital Signal Processing
Department	Biomedical
Course Type	Core
Semester	5
Credits	4
Contact Hours	45

Preamble: This subject builds upon the material introduced in the third year Digital Signal Processing course, focusing exclusively on digital signal processing techniques. Most signal processing is nowadays done on digital processors (including your smartphone). Although some real-world signals are discrete, most signals are in analog form which naturally requires a conversion of these signals to digital form and possibly (though not necessarily always) conversion back to the analog form following the processing. Digital signal processing offers a number of advantages over analog signal processing. Firstly, digital processors can be easily reconfigured by changing the code (algorithm) and therefore hardware changes can often be avoided if there is a change in the scenario. This flexibility can reduce cost. Secondly, once a signal is transformed to a series of numbers, a myriad of mathematical tools can then be applied that would otherwise be difficult or even impossible on an analog processor. In fact, we may think of signals as mathematical objects that have certain properties and to which a vast array of mathematical tools can be used. This course aims to deepen the understanding gained in the third-year course and to extend it by introducing new topics

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

1. Illustrate digital signals, systems and their significance.
2. Analyse the digital signals using various digital transforms DFT, FFT etc.
3. Design and develop the basic digital filters
4. Interpret the finite word length effects on functioning of digital filters.

Course Aims:

In this subject, we aim to give you a solid foundation in the important concepts that allow this process to take place. These include the conversion from analog to digital and vice versa, signal representation and interpretation, digital filtering, transforms, noise and its implications, detection, estimation and prediction. The subject is effectively divided into two main parts: deterministic signal processing and statistical signal processing. Below is an indicative topics list: Sampling, aliasing and the relationship between discrete and continuous signals Review of Fourier transforms, the Z-transform, FIR and IIR filters, and oscillators Filter implementation techniques, structures and numerical round-off effects Filter design techniques Auto-correlation, cross-correlation, and power spectrum estimation techniques Detection Estimation Linear prediction Wiener filters, LMS adaptive filters, and applications Multi-rate signal processing and subband transforms Time-frequency analysis, the short time Fourier transform, and wavelet transforms. Note that we may not cover all of these topics, but we will endeavour to get through as many of them as possible during the semester.

Course Expectations:

1. Signal analysis techniques: Students should be able to apply various signal analysis techniques, such as convolution, correlation, and filtering, to process and manipulate digital signals.
2. Applications: Students should be aware of various practical applications of digital signal processing, such as audio processing, image processing, telecommunications, and biomedical signal processing.
3. Signal processing tools: Familiarity with software tools commonly used in DSP, such as MATLAB, Python with libraries like NumPy and SciPy, or specialized DSP development environments.

Policy:

Academic honesty and Plagiarism: Plagiarism is the unacknowledged use of other people's work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a form of academic misconduct, and will attract some severe penalties.

General Conduct and Behaviour: Conduct which unduly disrupts or interferes with a class is not acceptable and students may be asked to leave the class. Use a professional and respectful language for in-classroom communications and emails.

Assignment deadlines: Late assignments (e.g., HW, lab reports) will not be graded. You are responsible to make sure that we receive your assignment on time.

Grading: Grades cannot be changed after they have been electronically entered into the linways except for the faculty error. Any extenuating circumstances that may adversely affect your grade must be brought to my attention before the final course grades are recorded. To be considered, such circumstances must be unusual, unavoidable, and verifiable. If you have any issues with grading of an assignment or exam, contact me within a week from when the assignment was returned.

Classroom attendance and behaviour: You are strongly encouraged to attend classes regularly. Attendance will be given only if you are present in the class within 5 minutes of the commencement of that period. Students are not permitted to enter the class after 10 minutes of the commencement of that period. Random quizzes will be held on a weekly basis. Missing a class could mean missing the quiz and the associated credit. No remake quizzes will be offered.

Learning Resources:

1. Holton, Thomas, Digital Signal Processing: Principles and Application, Cambridge University Press; 1st edition (18 February 2021)
2. Prandoni, Paolo and Vetterli, Martin, Signal Processing For Communications, EPFL Press, 2008.
3. Proakis, John G. & Manolakis, Dimitris G. Digital Signal Processing, 4th edition, Prentice-Hall International, 2006, ISBN: 978-0-131-87374-2
4. https://nptel.ac.in/courses/108105055
5. https://nptel.ac.in/courses/108101174
6. https://nptel.ac.in/courses/117102060

Assessment Methods:

There are three components in this course's assessment.

Attendance: 10 marks

Assignments: 15 Maks

1. Active participation in classrooms and tutorials: students will receive a mark for engagement in discussions and attempts on in-class exercises in each session.
2. Written Assignments: Each assignment will consist of a set of questions, requiring written answers with explanations as appropriate, as well as Matlab code fragments with numerical and graphical outputs.
3. Quiz Assessment: The quiz will be held in the middle of the semester and is intended to give you an opportunity to assess your command of the material up to that point. The quiz will be marked based on your understanding.

Tests: 25 Marks. Two tests will be conducted centrally by the college with a duration of 2 hours. Policy for retest will be as decided and approved by the Institution.

Learning Activities:

The teaching in this course aims at establishing a good fundamental understanding of the areas covered using:

1. Formal offline lectures that provide you with a focus on the core analytical material in the course, together with qualitative, alternative explanations to aid your understanding;
2. Tutorials that allow for exercises in problem solving and allow time for you to resolve problems in understanding of lecture material, while also providing opportunities for you to stretch your understanding to a variety of application domains;
3. Laboratory/project sessions that support the formal lecture material and allow you to develop confidence in your ability to convert the formal material into solutions to important practical problems.

The teaching philosophy is heavily based on the interaction between the lecturer and students. The lecturer's main task is to impart the necessary insights and understanding to the students rather than simply deliver these concepts in a dry manner. So the lecturer is not there only to give you the mathematical equations on the board or for practice problem-solving. In fact, the practice of solving problems rests almost entirely with the students. Students are expected to seek help and ask questions to rectify any misunderstanding they may have or further deepen their

knowledge. The course organisation provides many channels and ample opportunity for students to seek clarifications and support. There will **45 contact hours in** the course. Students are expected to spend approximately **60 hours of self-study** (an average of 4 hours per week) and to prepare for assessments.

Real world applications:

1. Audio Processing: DSP is extensively used in audio processing applications like audio compression (e.g., MP3), noise reduction, echo cancellation, equalization, and audio effects (reverb, chorus, etc.).
2. Image and Video Processing: DSP techniques are employed in image and video compression standards (e.g., JPEG, H.264), image enhancement, object recognition, face detection, and video stabilization.
3. Biomedical Signal Processing: In biomedical applications, DSP is used for tasks like electrocardiogram (ECG) analysis, electroencephalogram (EEG) analysis, medical imaging (e.g., MRI, CT scans), and various physiological signal processing tasks.
4. Control Systems: DSP is used in control systems to process sensor data, perform control algorithms, and stabilize feedback loops in applications like robotics, automotive control, and industrial automation.
5. Consumer Electronics: DSP is employed in various consumer electronic devices, including smartphones (audio and image processing), digital cameras, smart TVs, and virtual assistants.

Module 1 Syllabus:

CO 1: Illustrate digital signals, systems and their significance

Learning Outcomes:

- Identify common types of digital signals and their properties, such as continuous-time and discrete-time signals.
- Describe the advantages and limitations of digital signal processing compared to analog signal processing.
- Evaluate the frequency response and stability of digital filters based on their pole-zero plots.

LOs	Brief Description
Identify	Problems are shown on PPT, students are asked to solve them. They find some functions have limit, some not etc. They are motivated to enquire why that happens. Discusses using videos, simulations or animations
Describe	
Evaluate	

Assessment Plan CO 1:

Type	Frequency	Delivery from the learner	Data Collection	Verification
Formative	Once in every 4 classes	Quizzes, questions, etc	In the class itself	Evaluates the answers; determines class average; give back the assignment sheets to the class and discusses the mistakes
	At the end of 8 classes	Solve one assignment		

Sample Examination Questions CO 1: (Minimum 15 questions)

1.

2.

3.

4.

Module 2 Syllabus:

CO 2: Design and develop the basic digital filters

Learning Outcomes:

- Apply the discrete Fourier transform (DFT) to analyze and process discrete-time signals in the frequency domain.
- Design and implement finite impulse response (FIR) and infinite impulse response (IIR) digital filters for specific signal processing tasks.

- Analyze the effect of sampling rate on signal reconstruction and aliasing in digital signal processing systems.
- Critique the trade-offs between various signal processing techniques and their applicability to different real-world scenarios.

LOs	**Brief Description**
Apply Design Analyse	Reading materials, narrated PPT and some relevant videos, Problems are shown on PPT, Students are grouped. Problems are shown on PPT, students are asked to solve them by group work. Exchanging the complete working out of the problems of one group with another group and then mutually check the answers. One student at random from each group can be asked to work out the problem on the board. Teacher gives feedback

Assessment Plan CO 2:

Type	**Frequency**	**Delivery from the learner**	**Data Collection**	**Verification**
Formative	Once in every 4 classes	Quizzes, questions, etc	In the class itself	Feedback by the teacher based on the evaluation and peer evaluation. Evaluates the answers; determines class average; give back the assignment sheets to the class and discusses the mistakes
	At the end of 8 classes	Evaluation of the problems of the group of students assigned to them, using a scheme of evaluation		

Sample Examination Questions CO 2: (Minimum 15 questions)

1.

2.

3.

4.

To be completed till the last module.

COURSE SCHEDULE

To prepare a detailed course schedule on an hourly basis with 35 hours for a 3credit course and 45 hours for a 4 credit course. It included all sorts of internal assessments except the 2 series tests.