Curriculum Structure for Honors Scheme

(ADVANCED SIGNAL PROCESSING)

(In light of NEP 2020)

(NEP_Version II)

Offered By

Department of Electronics & Telecommunication Engineering

For students admitted in 2023-24 onwards

Government College of Engineering, Amravati

(An Autonomous Institute of Government of Maharashtra)
Near Kathora Naka, Amravati, Maharashtra
PIN 444604
www.gcoea.ac.in

A. **Preamble:**

The Honours track is crafted in consonance with the National Education Policy (NEP) 2020, offering students an enriched and in-depth academic experience in their chosen discipline. These courses promote intellectual thoroughness, advanced research aptitude, and comprehensive understanding beyond foundational learning. Students engage in specialized projects and higher-level assignments that cultivate critical thinking, ethical philosophy, and interdisciplinary insight—essential attributes for academic and professional excellence.

Through this Honours pathway, learners are empowered to connect theory with real-world application, laying a strong foundation for postgraduate studies, research endeavors, innovation, and leadership in their chosen field. This program is designed to nurture scholarly curiosity, foster lifelong learning, and prepare students to become responsible contributors in a knowledge-driven society.

Honours Courses in Signal Processing:

The Honours Program in **Signal Processing** is designed to empower Electronics and Telecommunication Engineering students with advanced analytical and computational skills essential for interpreting and transforming signals across diverse domains. In alignment with the NEP 2020 vision of holistic and multidisciplinary education, this program integrates foundational theory with real-world applications, fostering innovation and lifelong learning.

Why Signal Processing? Signal Processing is the backbone of modern communication systems, multimedia technologies, biomedical instrumentation, and intelligent sensing. With the advent of 5G, IoT, and edge computing, the demand for signal processing expertise is rapidly expanding.

B. **Signal Processing skill set**

Structured across five specialized courses from the 3rd to 7th semesters

Emphasis on both continuous and discrete signal analysis, filtering, spectral estimation, and adaptive systems

Integration of tools like MATLAB, Python, and real-time DSP platforms

Exposure to interdisciplinary applications in biomedical, audio, radar, and wireless systems

C. **Program-Specific Outcomes For Honors in Signal Processing**

Master advanced techniques in time-frequency analysis, digital filter design, and statistical signal processing

Develop critical thinking and problem-solving skills through hands-on labs and capstone projects

Engage in undergraduate research and innovation aligned with NEP's focus on inquiry-driven learning

D. **Eligibility criteria:** Students with minimum CGPA of 7.5 without backlog courses at the end of fourth semester are eligible for admission to the Honors Scheme:Structure of the Honors course

E. Structure of the Honors course

E&Tc Department offer Honors Basket, Track-1 (Advanced Signal Processing)														
Category	**Course Code**	**Name of the Course**	**Teaching Scheme**				**Evaluation Scheme**							**Credits**
							Theory				**Practical**		**Total**	
			TH	TU	PR	Total	CT1	CT2	TA	ESE	--	--	100	3
PEH1	ET1521	DSP Architecture	3	--	--	3	15	15	10	60	--	--	100	3
PEH2	ET 1522	Digital Image and Video Processing	3	--	--	3	15	15	10	60	--	--	100	3
PEH3	ET 1621	Wavelet Signal Processing	3	--	--	3	15	15	10	60	--	--	100	3
PEH4	ET 1622	Advanced Digital Signal Processing	3	--	--	3	15	15	10	60	--	--	100	3
PEH5	ET 1721	Pattern Recognition and Computational Intelligence	3	--	--	3	15	15	10	60	--	--	100	3
PEH6	ET 1722	Adaptive Signal Processing	3	--	--	3	15	15	10	60	--	--	100	3
Total			18	--	--	18	--	--	--	--	--	--	600	**18**

F. **Career Pathways:** Graduates will be equipped for roles in:

- Telecommunications and embedded systems
- Audio and speech technology
- Biomedical signal analysis
- Research and higher education in signal processing and allied fields

PROGRAM ELECTIVES HONOR'S COURSES

Course Code			ET1521						Course category			PEH
Course Name			DSP ARCHITECTURE									
Teaching Scheme				Examination Scheme								Credits
Th	Tu	Pr	Total	Theory					Practical		Total	
				CT1	CT2	TA	ESE	ESE Duration	ICA	ESE		
03	00	00	03	15	15	10	60	2 hrs 30 min	00	00	100	03

Course Objectives: Students undergoing this course are expected to

I. To design custom architectures than general purpose computing architectures.
II. To study mapping and custom resource shared architectures.
III. To synthase and schedule using high level synthesis tools.
IV. To analyzing and improving the resulting architectures.

Course Content

Introduction to signal processing: Objectives and Pre-requisites, Review of digital logic, Timing and Power in digital circuits, Implementation Costs and Metrics, Example: Audio processing, Example: AlexNet, Architecture cost components, Examples of Architectures, Multi-objective Optimization, Number representation, Scientific notation and Floating point.
Basic FIR filter, Serial FIR filter architectures, Simple programmable architecture, Block diagrams and SFGs, Dataflow Graphs, Iteration period, FIR filter iteration period, IIR filter iteration period,
Retiming basic concept, Example and uses of retiming, Resource sharing: adder example, Changing iteration period, Hardware assumptions and constraint analysis, Mathematical formulation, Examples with formulation, Example: Biquad filter, Hardware architecture, Review biquad folding sets, Complete biquad hardware, FFT in Vivado HLS, FFT synthesis,
Analyze FFT implementation, FFT interface, Scheduling: problem formulation, Example: differential equation solver, Heuristic approaches to scheduling, Mathematical formulation, ILP formulation, List scheduling, Hardware model, Force Directed Scheduling, HLS on FFT, FFT Simulation and Optimization,
FFT on FPGA board, Simulating SoC and SDK, Background: Understanding ELF files, On-chip communication basics, Many-to-Many communication, AXI bus handshaking, Microblaze processor on FPGA, Performance counter AXI peripheral, HW accelerator for FPGA, DMA and arbitration, Network-on-chip basics, NoC: topologies and metrics, routing, switching and flow control, Systolic Arrays.

Text Book:

1. VLSI Digital Signal Processing, K. K. Parhi, Wiley 1999
2. DSP Integrated Circuits, L. Wanhammar, Academic Press, 1999
3. Digital Signal Processing, Avatar Singh and S. Srinivasan, Thomson Learning, 2004

Reference Book:

1. Proakis, John G., Digital signal processing: principles algorithms and applications, PHI.
2. Oppenheim, Alan V – Discrete-time signal processing, Pearson Education India.
3. Vaidyanathan, Parishwad P - Multirate systems and filter banks, Pearson Education India.
4. Vaidyanathan, Palghat P- The theory of linear prediction, Morgan and Claypool Publishers.
5. Haykin, Simon S. - Adaptive filter theory, Pearson Education India.
6. "Architectures for Digital Signal Processing", Peter Pirsch John Weily, 2008.

Web Resources:

NOC | Mapping Signal Processing Algorithms to Architectures (nptel.ac.in)
https://swayam.gov.in/nd1_noc19_ee70

Course Outcome:

On completion of the course, students will be able to

ET1521.1 Comprehend the knowledge and concepts of digital signal processing techniques.

ET1521.2 Apply the knowledge of DSP computational building blocks to achieve speed in DSP architecture or processor.

ET1521.3 Design mapping and custom resource shared architectures.

ET1521.4 Synthase and schedule using high level synthesis tools.

ET1521.5 Analyzing and improving the resulting architectures.

CO-PO-PSO Mapping as per NBA Jan -2016 Format

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
ET1521.1	3	2	0	2	0	0	0	0	0	0	0	0	2	2	0
ET1521.2	3	0	3	0	2	0	0	0	0	0	0	0	2	3	0
ET1521.3	3	0	3	2	0	0	0	0	0	0	0	0	2	3	0
ET1521.4	3	0	3	0	2	0	0	0	0	0	0	0	2	3	0
ET1521.5	0	3	0	2	0	2	0	0	0	0	0	0	2	3	0

0 - Not correlated 1 - Weakly Correlated 2 - Moderately Correlated 3 - Strongly Correlated

CO-PO-PSO Mapping as per NBA 1-Jan-2025 Format

CO	PO/PSO													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
ET1521.1	3	2	0	2	0	0	0	0	0	0	0	2	2	0
ET1521.2	3	0	3	0	2	0	0	0	0	0	0	2	3	0
ET1521.3	3	0	3	2	0	0	0	0	0	0	0	2	3	0
ET1521.4	3	0	3	0	2	0	0	0	0	0	0	2	3	0
ET1521.5	0	3	0	2	0	2	0	0	0	0	0	2	3	0

0 - Not correlated 1 - Weakly Correlated 2 - Moderately Correlated 3 - Strongly Correlated

Course Code	ET1522								Course category			PEH
Course Name	DIGITAL IMAGE AND VIDEO PROCESSING											
Teaching Scheme				Examination Scheme								Credits
Th	Tu	Pr	Total	Theory					Practical		Total	
				CT1	CT2	TA	ESE	ESE Duration	ICA	ESE		
03	00	00	03	15	15	10	60	2 hrs 30 min	00	00	100	03

Course Objectives: Students undergoing this course are expected to

I. To understand the basic fundamentals of digital image processing and Image Transforms.
II. To Master the Image Processing Techniques in Spatial Domain and Frequency Domain.
III. To learn the fundamentals of various Image restoration models.
IV. To understand the Basic Steps of Video Processing.
V. To learn the Mathematical and computational skills needed to understand the principal of 2-DMotion Estimation

Course Content

Fundamentals of Image Processing and Image Transforms: Digital Image fundamentals, Sampling and quantization of an Image, Relationship between pixels. Image Transforms: 2-D Discrete Fourier Transform, Properties, Discrete cosine Transform, Hadamard Transform.

Image Processing Techniques: Image Enhancement: Spatial Domain methods: Histogram Processing, Fundamentals of Spatial filtering, smoothing spatial filters, Sharpening Spatial filters.

Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening. Image Restoration: Degradation Model, Inverse Filtering, Least Mean Square Filters, Constrained Least Squares Restoration. Image segmentation, Morphological image processing, object representation, description and recognition.

Basic steps of Video Processing: Analog video, Digital video, Time varying image formation model, Geometric image formation, formation, sampling of video signal and video sampling rate conversion.

Fourier Analysis of Video Signals and Frequency Response of the Human Visual System: Multidimensional Continuous-Space and Discrete Signals and Systems, Frequency Domain Characterization of Video Signals, Frequency Response of the Human Visual System.

Video Modeling: Camera model, Object model, Scene model, 2-D motion models.

2-D Motion Estimation Optical flow, Pixel based motion estimation, Region based Motion estimation, Multi resolution motion estimation, Application of motion estimation in video coding, Waveform-Based Video Coding, Video Compression Standards.

Text Books:

1. Digital Image Processing by Rafael C Gonzalez & Richard E Woods, 3rd Edition
2. Multimedia Communication Technology, J. R. Ohm, Springer Publication.

Reference Books:

1. Fundamentals of Digital Image Processing by Anil K Jain
2. Digital Image Processing by William K Pratt
3. Video Coding for Mobile Communications, David Bull et al, Academic Press.
4. Handbook on Image and Video Processing, A. I. Bovik, Academic Press.
5. Digital Video, Tekalp, Prentice Hall.

Web Resources:

https://onlinecourses.nptel.ac.in/noc22_ee116/preview
https://archive.nptel.ac.in/courses/117/104/117104020/#

Course Outcome:

On completion of the course, students will be able to

ET1522. 1 Understand the basic fundamentals of digital image processing and Image Transforms.

ET1522. 2 Master the Image Processing Techniques in Spatial Domain and Frequency Domain.

ET1522. 3 Learn the fundamentals of various Image compression models.

ET1522. 4 Understand the Basic Steps of Video Processing.

ET1522. 5 Learn the Mathematical and computational skills needed to understand the principle of 2-D Motion Estimation

CO-PO-PSO Mapping as per NBA Jan -2016 Format

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
ET1522.1	3	2	0	2	0	0	0	0	0	0	0	0	2	2	0
ET1522.2	3	0	3	2	0	0	0	0	0	0	0	0	2	3	0
ET1522.3	3	3	0	2	0	0	0	0	0	0	0	0	2	3	0
ET1522.4	3	3	0	0	2	0	0	0	0	0	0	0	2	2	0
ET1522.5	3	3	0	2	0	0	0	0	0	0	0	0	2	3	0

0 - Not correlated 1 - Weakly Correlated 2 - Moderately Correlated 3 - Strongly Correlated

CO-PO-PSO Mapping as per NBA 1-Jan-2025 Format

CO	PO/PSO													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
ET1522.1	3	2	0	2	0	0	0	0	0	0	0	2	2	0
ET1522.2	3	0	3	2	0	0	0	0	0	0	0	2	3	0
ET1522.3	3	3	0	2	0	0	0	0	0	0	0	2	3	0
ET1522.4	3	3	0	0	2	0	0	0	0	0	0	2	2	0
ET1522.5	3	3	0	2	0	0	0	0	0	0	0	2	3	0

0 - Not correlated 1 - Weakly Correlated 2 - Moderately Correlated 3 - Strongly Correlated

Course Code	ET1621							Course category			PEH
Course Name	WAVELET SIGNAL PROCESSING										
Teaching Scheme				Examination Scheme							Credits
Th	Tu	Pr	Total	Theory					Practical		Total	
				CT1	CT2	TA	ESE	ESE Duration	ICA	ESE		
00	00	00	00	15	15	10	60	2 hrs 30 min	00	00	100	03

Course Objectives: Students undergoing this course are expected

I. To study Fourier series and transform (continuous and discrete)
II. To study basic concept and definition of TFA
III. To understand general properties, interference and pseudo WVD
IV. To study definition and interpretation of CWT

Course Content:

Basic definitions and concepts of Time Frequency Analysis: duration bandwidth principle, joint energy density, short-time Fourier transform (STFT), Wigner-Ville distributions and wavelet transforms.
Continuous Wavelet Transform: Wavelet transform-A first level introduction, Continuous time-frequency representation of signals, Properties of wavelets used in continuous wavelet transform, Continuous versus discrete wavelet transform. Discrete-Time Fourier Series, Discrete-Time Fourier Transform, Discrete Fourier Transform & Periodogram.
TFA: Basic Concepts & Definition, Bandwidth Equation, Instantaneous Frequency, Analytic Signals and Multicomponent Signals. Duration-Bandwidth Principle Joint Energy Density, Short Time Fourier Transform: Definition and Interpretations, General Properties, Applications of STFT.
Definition and Interpretations of WVD, Properties of WVD, Interference and Pseudo WVD, Cohen's class, Connections with Spectrogram, Applications of WVD.
Definition and Interpretations of CWT and DWT, Wavelets, TFA and Filtering Perspective, Scalogram, Scaling Function, Practical Aspects, Wavelet Maxima and Ridges, Application of CWT, Frame Theory: Quick Round-up, Multiresolution Approximation, Orthonormal Bases and Conjugate Mirror Filters, DWT Implementation: Pyramidal Algorithm, Choosing a Wavelet, Handling Boundary Effects, De-noising & Signal Estimation, Application of DWT.

Text Book:

1. Insight into Wavelets: From Theory to Practice, (Third Edition), K. P. Soman, K. I. Rmachandran, N. G. Resmi, PHI Learning Pvt. Ltd., 2010.
2. Introduction to Wavelets and Wavelet Transform, C. S. Burrus, Ramose and A. Gopinath, Prentice Hall Inc.

Reference Book:

1. A Wavelet Tour of Signal Processing, 2nd edition, S. Mallat, Academic Press, 1999.
2. Wavelet transforms: Introduction, Theory and applications, Raghuveer rao and Ajit S. Bopardikar, Pearson Education Asia, 2000.
3. Multiresolution signal Decomposition: Transforms, Subbands and Wavelets, A.N. Akansu and R.A. Haddad, Academic Press, Oranld, Florida, 1992.

4. Wavelets and signal processing: An application based introduction, Stark, Springer, 2005.
5. Insight into wavelets: From theory to Practice-K P Soman and K I Ramachandran, Prentice Hall of India

Web Resources:
https://archive.nptel.ac.in/noc/courses/noc16/SEM2/noc160ch05/

Course Outcome:

On completion of the course, students will be able to

ET1621.1 Study Continuous Time Fourier series and transform
ET1621.2 Study Discrete Time Fourier series and transform
ET1621.3 Study basic concept and definition of TFA
ET1621.4 Understand general properties, interference and pseudo WVD
ET1621.5 Describe interpretation of CWT and DWT

CO-PO-PSO Mapping as per NBA Jan-2016 Format

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
ET1621.1	3	2	0	0	0	0	0	0	0	0	0	0	2	3	0
ET1621.2	3	3	0	0	0	0	0	0	0	0	0	0	2	3	0
ET1621.3	3	2	0	0	0	0	0	0	0	0	0	0	2	3	0
ET1621.4	3	3	0	0	0	0	0	0	0	0	0	0	2	3	0
ET1621.5	3	3	0	0	0	0	0	0	0	0	0	0	2	3	0

0- Not Correlated 1-Weakly Correlated 2- Moderately Correlated 3- Strongly Correlated

CO-PO-PSO Mapping as per NBA 1-Jan-2025 Format

CO	PO / PSO													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
ET1621.1	3	2	0	0	0	0	0	0	0	0	0	2	3	0
ET1621.2	3	3	0	0	0	0	0	0	0	0	0	2	3	0
ET1621.3	3	2	0	0	0	0	0	0	0	0	0	2	3	0
ET1621.4	3	3	0	0	0	0	0	0	0	0	0	2	3	0
ET1621.5	3	3	0	0	0	0	0	0	0	0	0	2	3	0

0 - Not correlated 1 - Weakly Correlated 2 - Moderately Correlated 3 - Strongly Correlated

Course Code	ET1622								Course category			PEH
Course Name	ADVANCED DIGITAL SIGNAL PROCESSING											
Teaching Scheme				Examination Scheme								Credits
Th	Tu	Pr	Total	Theory					Practical		Total	
				CT1	CT2	TA	ESE	ESE Duration	ICA	ESE		
00	00	00	00	15	15	10	60	2 hrs 30 min	00	00	100	03

Course Objectives: Students undergoing this course are expected to

I. Understand the basic concept of Wavelet and Multirate DSP
II. Understand the idea of wavelets, and the related notions of time frequency analysis, of time-scale analysis.
III. Know about the technical developments related to wavelets applications.
IV. Study multi-rate filter banks.
V. Apply the algorithms for wide area of recent applications.

Course Content:

Basic concepts of signals system theory: digital signal processing & discrete time signal processing, time-frequency analysis, Concept of Wavelets and Multirate Digital Signal Processing, multiresolution/ multiscale analysis, Piecewise constant approximation - the Haar wavelet, concept of dyadic Multiresolution Analysis (MRA), Equivalence - Functions And Sequences, Haar Filter Bank Analysis and Synthesis, Relating psi, phi and the Filters, Iterating the filter bank from Psi, Phi, Z-Domain Analysis Of Multi-rate Filter Bank, Two Channel Filter Bank, Perfect Reconstruction: Conjugate Quadrature Filters - Daubechies Family of MRA, Daubechies' Filter Banks.

Time and Frequency: Joint Perspective, Ideal Time Frequency behavior, The Uncertainty Principle, Time Bandwidth Product Uncertainty, Evaluating and Bounding square root omega, The Time Frequency Plane & its Tilings.

Short time Fourier Transform & Wavelet Transform: Reconstruction & Admissibility, Admissibility in Detail Discretization of Scale, Logarithmic Scale Discretization, Dyadic Discretization, Theorem of (DYADIC) Multiresolution Analysis, Variants of The Multiresolution Analysis Concept, JPEG 2000 5/3 Filter Bank & Spline MRA, Orthogonal Multiresolution Analysis with Splines, Building Piecewise Linear Scaling Function, Wavelet, Wave Packet Transform, Nobel Identities & The Haar Wave Packet Transform, Lattice Structure for Orthogonal Filter Banks, Constructing the Lattice & its Variants.

Lifting Structure & Polyphase Matrices: Polyphase Approach - The Modulation Approach, Modulation Analysis and the 3-Band Filter Bank, Applications, Applications of Data Mining and Face Recognition, M-Band Filter Banks.

Two band Filter Bank: Frequency Domain Analysis of Two band Filter Bank, Zoom in and Zoom out using Wavelet Transform, Wavelets through vanishing moments, Scaling Coefficients, Wavelet Applications.

Text Books:

1. The World according to Wavelets - A Story of a Mathematical Technique in the making, by Barbara Burke Hubbard, Second Edition, Universities Press (Private) India Limited 2003,
2. Fractal and Wavelet Image Compression Techniques, by Stephen Welstead, Prentice Hall of India, New Delhi – Eastern Economy Edition, ISBN 810203 282702,
3. Fourier and Wavelet Analysis, by George Bachman, Lawrence Narici, Edward Beckenstein, Springer International Edition (SIE), ISBN 8108128027600.

Reference Books:

1. Wavelet Analysis: The Scalable Structure of Information ,by Howard L. Resnikoff, Raymond O. Wells, Springer, 1998: available in Indian Edition.
2. Wavelet Transforms: Introduction to Theory and Applications by Raghuveer M. Rao, Ajit S. Bopardikar,
3. Insight Into Wavelets - From Theory to Practice,by K. P. Soman, K. I. Ramachandran, Prentice Hall of India, Eastern Economy Edition
4. An Introduction to Wavelets Through Linear Algebra, Michael W. Frazier, Springer,
5. Multirate Systems and Filter Banks, by P. P. Vaidyanathan, Pearson Education, Low Price Edition

Web Resources:

https://archive.nptel.ac.in/courses/117/101/117101001/

Course Outcomes:

On completion of the course, students will be able to

ET1622.1 Describe Basic exposition to signals system theory perhaps digital signal processing and discrete time signal processing.

ET1622.2 Introduce the idea of wavelets, and the related notions of time frequency analysis, of time-scale analysis.

ET1622.3 Describe the manner in which technical developments related to wavelets have led to numerous applications.

ET1622.4 Design multi-rate filter banks.

ET1622.5 Verify algorithms for wide area of recent applications.

CO-PO-PSO Mapping as per NBA Jan-2016 Format

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
ET1622.1	3	3	1	2	0	0	0	0	0	0	0	0	2	2	0
ET1622.2	3	2	3	2	0	0	0	0	0	0	0	0	2	3	1
ET1622.3	2	3	0	3	1	0	0	0	0	0	0	0	2	3	1
ET1622.4	3	3	3	2	2	0	0	0	0	0	0	0	3	1	1
ET1622.5	3	3	0	3	2	0	0	0	0	0	0	0	2	3	1

0 - Not correlated 1 - Weakly Correlated 2 - Moderately Correlated 3 - Strongly Correlated

CO-PO-PSO Mapping as per NBA 1-Jan-2025 Format

CO	PO / PSO													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
ET1622.1	3	3	1	2	0	0	0	0	0	0	0	2	2	0
ET1622.2	3	2	3	2	0	0	0	0	0	0	0	2	3	1
ET1622.3	2	3	0	3	1	0	0	0	0	0	0	2	3	1
ET1622.4	3	3	3	2	2	0	0	0	0	0	0	3	1	1
ET1622.5	3	3	0	3	2	0	0	0	0	0	0	2	3	1

0 - Not correlated 1 - Weakly Correlated 2 - Moderately Correlated 3 - Strongly Correlated

Curriculum Structure for Honors Scheme

(SOFT COMPUTING)

(In light of NEP 2020)

(NEP_Version II)

Offered By

Department of Electronics & Telecommunication Engineering

For students admitted in 2023-24 onwards

Government College of Engineering, Amravati

(An Autonomous Institute of Government of Maharashtra)
Near Kathora Naka, Amravati, Maharashtra
PIN 444604
www.gcoea.ac.in

A. **Preamble:**

The Honours Program in **Artificial Intelligence** offers an immersive, future-ready curriculum for Electronics and Telecommunication Engineering students aspiring to lead in the AI revolution. Rooted in the NEP 2020 principles of flexibility, interdisciplinary, and skill-based learning, this program bridges core AI concepts with domain-specific applications in E&TC.

Why AI for E&TC? AI is transforming how electronic systems perceive, learn, and act. From intelligent communication networks to autonomous systems and smart sensors, AI is redefining the landscape of electronics and telecommunication.

B. **Artificial Intelligence skill set**

Five progressive courses from the 3rd to 7th semesters covering:

- Machine learning and deep learning
- Natural language processing and computer vision
- AI hardware acceleration and edge AI

Integration with signal processing, VLSI, and embedded systems

Project-based learning and exposure to open-source AI frameworks

C. **Program-Specific Outcomes For Honors In** Artificial Intelligence

Build and deploy intelligent systems using neural networks, decision trees, and reinforcement learning

Analyse large-scale data and extract actionable insights

Apply AI to solve real-world problems in communication, automation, and sensing

D. Eligibility criteria: Students with minimum CGPA of 7.5 without backlog courses at the end of fourth semester are eligible for admission to the Honors Scheme

E. **Structure of the Honors course:**

E&Tc Department offer Honors Basket , Track-2 (Soft Computing)														
Category	**Course Code**	**Name of the Course**	**Teaching Scheme**				**Evaluation Scheme**							**Credits**
							Theory				**Practical**		**Total**	
			TH	TU	PR	Total	CT1	CT2	TA	ESE	ICA	ESE		
PEH1	ET1551	Artificial Intelligence	3	--	--	3	15	15	10	60	--	--	100	3
PEH2	ET1552	Introduction to Soft Computing and Machine Learning	3	--	--	3	15	15	10	60	--	--	100	3
PEH3	ET1651	Computer Vision	3	--	--	3	15	15	10	60	--	--	100	3
PEH4	ET1652	Natural Language Processing	3	--	--	3	15	15	10	60	--	--	100	3
PEH5	ET1751	Optimization Methods in Machine Learning	3	--	--	3	15	15	10	60	--	--	100	3
PEH6	ET1752	Hardware for Deep Learning	3	--	--	3	15	15	10	60	--	--	100	3
Total			18	--	--	18	--	--	--	--	--	--	600	**18**

F. **Career Pathways:** Graduates will be equipped for roles in:

- Telecommunications and embedded systems
- Audio and speech technology
- Biomedical signal analysis
- Research and higher education in signal processing and allied fields

G. **Career Pathways:** Graduates will be prepared for:

AI and data science roles in telecom, healthcare, and smart infrastructure

Research in AI-driven signal processing and robotics.

Advanced studies in AI, ML, and cognitive systems

Course Code	ET1551							Course category			PEH
Course Name	ARTIFICIAL INTELLIGENCE										
Teaching Scheme				Examination Scheme							Credits
Th	Tu	Pr	Total	Theory					Practical		Total	
				CT1	CT2	TA	ESE	ESE Duration	ICA	ESE		
03	00	00	03	15	15	10	60	2 hrs 30 min	00	00	100	03

Course Objectives: Students undergoing this course are expected to

I. To acquire the basic concepts of AI
II. To Formulate Problems and Evaluation of Uniformed and Informed Search Strategies
III. To understand the various searching techniques, constraint satisfaction problem and example Problems game playing techniques.
IV. To make aware about knowledge-based systems and Predicate Logic

Course Contents:

Introduction to Artificial Intelligence: The Foundations of Artificial Intelligence, The History of Artificial Intelligence, The State of the Art, Risks and Benefits of AI, Intelligent Agents: Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents.

Problem Solving & Search Strategies: Problems, Problem Space and Search: Production Systems, Problem Characteristics, Production System Characteristics, Issues in the Design of Search Programs. Problem trees and graphs. Uninformed Search Strategies: Breadth First Search, Depth First Search, Depth Limited Search, Iterative Deepening Depth First Search, Bidirectional Search.

Informed Search Strategies: Generate-and-Test, Hill Climbing, Best-first Search, A* Algorithm, Problem Reduction, AND-OR Graphs, The AO* Algorithm, Minmax Algorithm. Constraint Satisfaction, Means ends Analysis.

Knowledge Representation using Predicate Logic: Knowledge Representation and approaches, representing simple facts in logic, augmenting the representation, resolution, conversion to clause form, Resolution in Propositional Logic and Predicate Logic, Unification Algorithms, Question Answering and Natural Deduction

Symbolic Reason under Uncertainty: Introduction to Non-Monotonic Reasoning, Logics for Non-Monotonic Reasoning, Semantic Nets, Statistical Reasoning, Statistical Reasoning: Probability and Bayes' theorem, Bayesian Networks.

Text Books:

1. Artificial Intelligence ,Elaine Rich, Kevin Knight, Nair (Third Edition) [Mc Graw Hill]
2. Artificial Intelligence: A Modern Approach, Stuart Russell & Peter Norvig (Pearson - 4th Ed.)
3. Artificial Intelligence, Patrick Henry Winston, Third Edition, Addison-Wesley Publishing Company, 2004.
4. Principles of Artificial Intelligence, Nils J Nilsson, Springer Heidelberg, 2014.

Reference Books:

1. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, 3rd Edition, PHI2009.
2. Quest for Artificial Intelligence, Nils J. Nilsson, First Edition, Cambridge University Press, 2010.
3. Introduction to Artificial Intelligence and expert system ,Dan W. Patterson
4. Introduction to Artificial Intelligence , Rajendra Akerkar
5. A First Course in Artificial Intelligence, Deepak Khemani (Tata McGraw Hill 1st Ed.)
6. Artificial Intelligence and Expert Systems by Patterson (PHI)
7. Principles of Artificial Intelligence and Expert Systems, Rolston McGraw Hill.

Web Resources:

Fundamentals Of Artificial Intelligence: https://onlinecourses.nptel.ac.in/noc21_ge20/preview

Course Outcome:

On completion of the course, students will be able to

ET1531.1 Explain concepts of Artificial Intelligence and different types of intelligent agents and their architecture.

ET1531.2 Evaluate different informed and uninformed search algorithms on well formulate problems along with stating valid conclusions that the evaluation supports.

ET1531.3 Formulate and solve given problem using Propositional and first order logic.

ET1531.4 Apply reasoning for non-monotonic AI problems.

ET1531.5 Have a basic understanding of some of the more advanced topics of AI such as learning, Understanding, Natural Language Processing.

CO-PO-PSO Mapping as per NBA Jan -2016 Format

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
ET1531.1	3	2	0	2	1	0	0	0	0	0	0	0	1	2	0
ET1531.2	3	3	0	2	0	1	0	0	0	0	0	0	1	3	0
ET1531.3	3	3	0	2	0	1	0	0	0	0	0	0	1	3	0
ET1531.4	3	3	0	2	0	1	0	0	0	0	0	0	1	3	0
ET1531.5	3	2	0	2	1	0	0	0	0	0	0	0	1	2	0

0 - Not correlated 1 - Weakly Correlated 2 - Moderately Correlated 3 - Strongly Correlated

CO-PO-PSO Mapping as per NBA 1-Jan-2025 Format

CO	PO/PSO													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
ET1531.1	3	2	0	2	1	0	0	0	0	0	0	1	2	0
ET1531.2	3	3	0	2	0	1	0	0	0	0	0	1	3	0
ET1531.3	3	3	0	2	0	1	0	0	0	0	0	1	3	0
ET1531.4	3	3	0	2	0	1	0	0	0	0	0	1	3	0
ET1531.5	3	2	0	2	1	0	0	0	0	0	0	1	2	0

0 - Not correlated 1 - Weakly Correlated 2 - Moderately Correlated 3 - Strongly Correlated

Course Code	ET1552						Course category			PEH
Course Name	INTRODUCTION TO SOFT COMPUTING AND MACHINE LEARNING									
Teaching Scheme				Examination Scheme						Credits
Th	Tu	Pr	Total	Theory					Practical		Total	
				CT1	CT2	TA	ESE	ESE Duration	ICA	ESE		
03	00	00	03	15	15	10	60	2 hrs 30 min	00	00	100	03

Course Objectives: Students undergoing this course are expected to

I. Develop the skills to gain a basic understanding of neural network theory and fuzzy logic theory.
II. Introduce students to Genetic algorithms and traditional optimization method.
III. Introduce students to artificial neural networks and fuzzy theory from an engineering perspective
IV. Discuss the applications of Fuzzy logic and neural network

Course Content

Introduction to Soft Computing and Fuzzy logic: Fuzzy membership functions, Operations on Fuzzy sets Fuzzy relations, Fuzzy propositions, Fuzzy implications, Fuzzy inferences, Defuzzyfication Techniques-I, Defuzzyfication Techniques-II, Fuzzy logic controller-I, Fuzzy logic Controller -II

Derivative free Optimization Genetic algorithms: Basic concepts, encoding, fitness function, and reproduction. Differences of GA and traditional optimization methods. Basic genetic programming concept Applications.

Introduction to EC-I, Introduction to EC-II, MOEA Approaches: Non-Pareto, MOEA Approaches: Pareto-I MOEA Approaches: Pareto-II, Introduction to ANN, ANN Architecture ANN Training-I, ANN Training-II, ANN Training-III, Applications of ANN

Neural networks: Single layer networks, Perceptrons: Adaline, Mutilayer Perceptrons Supervised Learning, Back-propagation, LM Method, Radial Basis Function Networks, Unsupervised Learning Neural Networks, Competitive Learning Networks, Kohonen Self-Organizing Networks, Learning Vector Quantization, Hebbian Learning. Recurrent neural networks, Adaptive neuro-fuzzy information; systems (ANFIS), Hybrid Learning Algorithm, Applications to control and pattern recognition.

Text Book:

1. Fuzzy Logic with Engineering Applications Timothy J. Ross (Wiley)
2. Neural Networks and Learning Machines Simon Haykin (PHI)
3. Neuro-Fuzzy and Soft Computing, J. S. R. Jang, C. T. Sun and E. Mizutani, PHI, 2004, Pearson Education 2004.
4. Fuzzy Logic with Engineering Applications, Timothy J. Ross, McGraw-Hill, International Editions, Electrical Engineering Series, Singapore, 1997.

Reference Book:

1. An Introduction to Genetic Algorithm, Melanic Mitchell (MIT Press)

2. Evolutionary Algorithm for Solving Multi-objective, Optimization Problems (2nd Edition), Collelo, Lament, Veldhnizer (Springer)

3. Neural Network fundamental with Graph, Algorithms & Applications, N. K. Bose, Ping Liang, TMH, 1st Edition, 1998.
4. Neural Network & Fuzzy System, Bart Kosko,PHI Publication, 1st Edition, 2009. 3. Rich E, Knight K, Artificial Intelligence, TMH, 3rd Edition, 2012.
5. Fuzzy sets & Fuzzy Logic, Theory & Applications, George J Klir, Bo Yuan, PHI Publication, 1st Edition, 2009.
6. Neural Network Design, Martin T Hagen, Nelson Candad, 2nd Edition, 2008.

Web Resources:

a. Introduction to Soft Computing: https://onlinecourses.nptel.ac.in/noc22_cs54/preview
b. Introduction to Machine Learning: https://onlinecourses.nptel.ac.in/noc24_cs51/preview

Course Outcome:

On completion of the course, students will be able to

ET1532.1 Learn about soft computing techniques and their applications
ET1532.2 Analyze various neural network architectures
ET1532.3 Understand perceptrons and counter propagation networks.
ET1532.4 Define the fuzzy systems
ET1532.5 Analyze the genetic algorithms and their applications.

CO-PO-PSO Mapping as per NBA Jan -2016 Format

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
ET1532.1	3	3	0	2	0	0	0	0	0	0	0	0	2	2	0
ET1532.2	3	3	0	2	0	0	0	0	0	0	0	0	2	3	0
ET1532.3	3	3	0	2	0	1	0	0	0	0	0	0	2	3	0
ET1532.4	3	3	0	2	1	0	0	0	0	0	0	0	2	3	0
ET1532.5	3	3	1	2	0	1	0	0	0	0	0	0	2	3	0

0 - Not correlated 1 - Weakly Correlated 2 - Moderately Correlated 3 - Strongly Correlated

CO-PO-PSO Mapping as per NBA 1-Jan-2025 Format

CO	PO/PSO													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
ET1532.1	3	3	0	2	0	0	0	0	0	0	0	2	2	0
ET1532.2	3	3	0	2	0	0	0	0	0	0	0	2	3	0
ET1532.3	3	3	0	2	0	1	0	0	0	0	0	2	3	0
ET1532.4	3	3	0	2	1	0	0	0	0	0	0	2	3	0
ET1532.5	3	3	1	2	0	1	0	0	0	0	0	2	3	0

0 - Not correlated 1 - Weakly Correlated 2 - Moderately Correlated 3 - Strongly Correlated

Course Code	ET 1651							Course category			PEH
Course Name	COMPUTER VISION										
Teaching Scheme				Examination Scheme							Credits
Th	Tu	Pr	Total	Theory					Practical		Total	
				CT1	CT2	TA	ESE	ESE Duration	ICA	ESE		
00	00	00	00	15	15	10	60	2 hrs 30 min	00	00	100	03

Course Objectives: Students undergoing this course are expected

I. To solve real world problems with image or video as input, understanding the real-world scene is important from the input.
II. To make the use of low-level image processing, pattern recognition algorithms to provide information about the real-world scene.
III. To design the algorithms to understand real world scene and provide information about the real-world objects.
IV. To understand the applications in many areas such as biometric, medical image diagnosis, surveillance etc.

Course Content:

Image processing: Fundamentals of image processing, color processing, and range image processing

Geometry: 2-D projective geometry, homography, camera geometry, and stereo geometry

Feature detection: Feature detection and description, feature matching, and model fitting

Machine learning: Deep neural architecture and applications, and the basics of machine learning and deep learning for computer vision

Signal processing: Digital signal processing and multi-dimensional signal processing

Pattern analysis: Pattern analysis and visual geometric modeling Optimization, Stochastic optimization

Text Books:

1. Multiple View Geometry in Computer Vision: R. Hartley and A. Zisserman, Cambridge University Press.
2. Computer Vision: Algorithms & Applications, R. Szeleski, Springer

Reference Books:

1. Computer vision: A modern approach: Forsyth and Ponce, Pearson.
2. Computer Vision: Algorithms and Applications, Springer-Verlag London Limited, Richard Szeliski.
3. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce,Pearson Education, 2003

Web Resources:

Computer Vision: https://onlinecourses.nptel.ac.in/noc19_cs58/preview

Course Outcome:

On completion of the course, students will be able to

ET1631.1 Learn fundamentals of computer vision and its applications

ET1631.2 Understand the basic image processing operations to enhance, segment the images.

ET1631.3 Understand the analyzing and extraction of relevant features of the concerned domain problem.

ET1631.4 Understand and apply the motion concepts and its relevance in real time applications

ET1631.5 Apply the knowledge in solving high level vision problems like object recognition, image classification etc

CO-PO-PSO Mapping as per NBA Jan-2016 Format

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
ET1631.1	1	1	1	0	0	0	0	0	0	0	0	0	2	0	0
ET1631.2	0	0	0	1	2	0	0	0	0	2	1	1	0	0	0
ET1631.3	2	1	0	0	0	0	0	0	1	0	0	0	0	1	1
ET1631.4	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0
ET1631.5	1	0	0	0	0	0	0	2	0	0	0	0	2	0	0

0 - Not correlated 1 - Weakly Correlated 2 - Moderately Correlated 3 - Strongly Correlated

CO-PO-PSO Mapping as per NBA 1-Jan-2025 Format

CO	PO / PSO													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
ET1631.1	1	1	1	0	0	0	0	0	0	0	0	2	0	0
ET1631.2	0	0	0	1	2	0	0	0	2	1	1	0	0	0
ET1631.3	2	1	0	0	0	0	0	1	0	0	0	0	1	1
ET1631.4	0	0	0	0	1	0	1	0	0	1	0	0	0	0
ET1631.5	1	0	0	0	0	0	2	0	0	0	0	2	0	0

0 - Not correlated 1 - Weakly Correlated 2 - Moderately Correlated 3 - Strongly Correlated

Course Code	ET 1652								Course category			PEH
Course Name	NATURAL LANGUAGE PROCESSING											
Teaching Scheme				Examination Scheme								Credits
Th	Tu	Pr	Total	Theory					Practical		Total	
				CT1	CT2	TA	ESE	ESE Duration	ICA	ESE		
00	00	00	00	15	15	10	60	2 hrs 30 min	00	00	100	03

Course Objectives: Students undergoing this course are expected

I. To understand linguistic phenomena and learn to model them with formal grammars.
II. To understand and carry out proper experimental methodology for training and evaluating empirical NLP systems.
III. To learn how to manipulate probabilities, construct statistical models over string sand trees
IV. To estimate parameters using supervised and unsupervised training methods.
V. To design, implement, and analyze NLP algorithms. Able to design different language modeling Techniques.

Course Content:

Natural Language processing (NLP) : Introduction, Applications or Use cases of NLP, Components of NLP, Steps in NLP, Finding the Structure of Words: Words and Their Components, Lexemes, Morphemes, Morphology, Problems in morphological processing, Typology, Morphological Typology

Natural Language Processing with python NLTK package (Text Preprocessing Tasks): Word Tokenization, Sentence Tokenization, Filtering Stop words, Stemming, Tagging Parts of Speech, Lemmatization, Chunking, Chinking, Named Entity Recognition, Term Frequency and Inverse Document Frequency (TF-IDF)

Syntax Analysis: Parsing Natural Language, Tree banks: A Data-Driven Approach to Syntax, Representation of Syntactic Structure: Syntax Analysis using Dependency Graph, Syntax Analysis using Phrase Structure Trees, Parsing Algorithms: Shift Reduce Parsing, Hyper Graphs and Chart Parsing (CYK Parsing), Models for ambiguity Resolution in Parsing: Probabilistic Context Free Grammar, Generative Models, Discriminative models for Parsing

Language Modeling: Introduction, N-Gram Models, Language Model Evaluation, Parameter Estimation, Language Model Adaptation, Types of Language Models, Language-Specific Modeling Problems.

Semantic Parsing: Introduction, Semantic Interpretation, System Paradigms, Word Sense Systems, Software Predicate-Argument Structure, Meaning Representation Systems, Software. Discourse Processing: Cohesion, Reference Resolution, Discourse Cohesion and Structure.

Text Books:

1. Multilingual natural Language Processing Applications: From Theory to Practice– Daniel M. Bikel and Imed Zitouni, Pearson Publication.
2. Speech and Natural Language Processing- Daniel Jurafsky & James H Martin, Pearson Publications.

Reference Books:

1. Speech and Language Processing, by Dan Jurafsky and James Martin. Prentice Hall, Second Edition, 2009.
2. Foundations of Statistical Natural Language Processing by Chris Manning and Hinrich Schütze, MIT Press, Cambridge
3. Natural Language Processing and Information Retrieval: Tanvier Siddiqui, U. S. Tiwary.

Web Resources:

Natural Language Processing: https://onlinecourses.nptel.ac.in/noc23_cs45/preview

Course Outcome:

On completion of the course, students will be able to

ET1632.1 Show sensitivity to linguistic phenomena and an ability to model them with formal grammars.

ET1632.2 Understand and carry out proper experimental methodology for training and evaluating Empirical NLP systems.

ET1632.3 Able to manipulate probabilities, construct statistical models over strings and trees

ET1632.4 Will be able to estimate parameters using supervised and unsupervised training methods.

ET1632.5 Able to design, implement, and analyze NLP algorithms. Able to design different language modeling Technique

CO-PO-PSO Mapping as per NBA Jan-2016 Format

CO	PO / PSO														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
ET1632.1	1	1	1	0	0	0	0	0	0	0	0	0	2	0	0
ET1632.2	0	0	0	1	2	0	0	0	0	2	1	1	0	0	0
ET1632.3	2	1	0	0	0	0	0	0	1	0	0	0	0	1	1
ET1632.4	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0
ET1632.5	1	0	0	0	0	0	0	2	0	0	0	0	2	0	0

0 - Not correlated 1 - Weakly Correlated 2 - Moderately Correlated 3 - Strongly Correlated

CO-PO-PSO Mapping as per NBA 1-Jan-2025 Format

CO	PO / PSO													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
ET1632.1	1	1	1	0	0	0	0	0	0	0	0	2	0	0
ET1632.2	0	0	0	1	2	0	0	0	2	1	1	0	0	0
ET1632.3	2	1	0	0	0	0	0	1	0	0	0	0	1	1
ET1632.4	0	0	0	0	1	0	1	0	0	1	0	0	0	0
ET1632.5	1	0	0	0	0	0	2	0	0	0	0	2	0	0

0 - Not correlated 1 - Weakly Correlated 2 - Moderately Correlated 3 - Strongly Correlated