*Suggested Teaching Guidelines for*

# *Natural Language Processing & Computer Vision*

# *PG-DAI August 2025*

**Duration**: 40 Classroom hours and 60 Lab hours

**Objective:** To Introduce the students to Natural Language Processing &Computer Vision.

**Prerequisites:** Good knowledge of Python Programming and fundamentals of Artificial Intelligence.

**Evaluation method:** Theory exam– 40%
Lab Exam - 40%
Internal exam- 20%

**List of Books / Other training material**

**Courseware:**
Natural Language Processing, by Pushpak Bhattacharyya, Aditya Joshi / Wiley India, 2023

**Reference Book**:

1. The Big Book of NLP Techniques by Shlomo Vaknin
2. Theory and Practice of NLP Coaching: A Psychological Approach by Bruce Grimley

**Note:**

- **Each session mentioned is of 2 hours of Theory and 2 hours of Lab duration, unless indicated otherwise.**

**NLP (26 Hrs Theory + 44 Hrs Lab)**

**Session 1:**

**Lecture**

**Language in Cognitive Science**

- Definitions of language
- Language as a rule-governed dynamic system
- Knowledge of language: Innateness of Grammar
- Language as a biological, social and psychological phenomenon
- Modes of language: spoken and written
- Language system as expression and content
- Language and symbolic systems: Artificial language (Logical language/programming Language)vs. Natural Language
- Linguistics as a scientific study

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**Session 2:**

**Lecture**

**Language Analysis and Computational Linguistics**

Language Analysis:

- Paradigmatic and Syntagmatic relationship
- Form, Function and Meaning in Language Analysis
- Levels of Linguistic Analysis: Phonetics, Phonology, Morphology, Syntax, Semantics,
- Discourse, Pragmatics, Lexicology
- Artificial Intelligence (AI) and its sub disciplines
- Natural Language Understanding (NLU)
- Natural Language Generation (NLG)
- Natural Language Interaction (NLI)

**Assignment:** Difference between Semantics and Pragmatics

**Session 3: (2 Hrs of Theory + 4 Hrs of Lab)**

**Lecture**

**Shallow Parsing and Tools for NLP**

- Morphological Analysis
- Tokenization & PoS Tagging
- Chunking & Multi word expression (MWE)
- Named-Entity Recognition
- Lemmatizer & Stemming
- Morphological Synthesis
- Word Sense Disambiguation
- Universal Networking Language

**Assignment:** Apply tok , stemming , lemma, and POS tagging for following data https://www.kaggle.com/arushchillar/disneyland-reviews

**Session 4: (2 Hrs of Theory + 4 Hrs of Lab)**

**Lecture**

**Deep Parsing and Tools for NLP**

- Syntactic Parsing Techniques and algorithms
- Semantic Parsing
- Information Extraction
- Automatic Summarization
- Anaphora Resolution, Pragmatics and Discourse analysis
- Ontology & Semantic Web

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**Session 5: (2 Hrs of Theory + 4 Hrs of Lab)**

**Lecture**

**Statistical Approaches**

- Probability Theory & Models
- Discrete Time Models
- Markov Models, Entropy Models
- Statistical Parsing
- Text Categorization / Classification and Clustering
- Text Classification Using Support Vector Machine (SVM)
- Centroid based Classification

**Session 6: (2 Hrs of Theory + 4 Hrs of Lab)**

**Lecture**

**NLP with Machine Learning and Deep Learning**

- Machine Learning & Deep Learning for NLP
- ML vs. DL along with respective algorithms names
- Linear Algebra Review
- ANN, RNN, CNN, DNN Long Short-Term Memory (LSTM)
- Gated Feedback Recurrent Neural Networks

**Assignment:** Difference between ANN, RNN and CNN

**Session 7: (2 Hrs of Theory + 4 Hrs of Lab)**

**Lecture**

**Study of Important ML/DL Algorithms & Case Studies:**

- Pre-processing
- Need of Pre-processing Data
- Introduction to NLTK, spaCy
- Using Python Scripts

**Session 8: (2 Hrs of Theory + 4 Hrs of Lab)**

- Introduction to gates, GRU and LSTM
- How LSTM and GRU resolves exploding and vanishing gradient problems

**Assignment –Lab:**

- Implement LSTM and GRU in python
- Sequence Modeling Lab
- Using Tensor Flow and python for music
- Generation using deep learning

**Session 9: (2 Hrs of Theory + 4 Hrs of Lab)**

- Sequence Modeling - Word representation
- word embedding matrix
- learning words and embedding's
- Sentiment classifications

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**Session 10: (2 Hrs of Theory + 4 Hrs of Lab)**

**Lecture**

**Word2Vec models (Skip-gram, CBOW, Glove, one hot Encoding)**

- Sequence-to-sequence models (Seq2Seq) - GloVe: Global Vectors for Word representation
- Brief on Sequence-to-Sequence Models
- RNN based Sequence-to-Sequence Model
- Challenges
- Transformer in NLP
- Understanding the Model Architecture
    - Getting Hang of Self- Attention
    - Calculation of Self-Attention
    - Limitations of the Transformer
- Transformer-XL oUsing Transformer for Language Modeling
- Using Transformer- XL for Language Modeling

**Session 11: (2 Hrs of Theory + 4 Hrs of Lab)**

- Bert in NLP
- Model Architecture
- BERT Pre-Training Tasks
- NLP Model Deployment Techniques using Flask

**Session 12 & 13:**

**Speech Processing**

- Articulatory Phonetics
- Speech Sounds and Phonetic Transcription
- Acoustic Phonetics
- Phonology
- Computational Phonology
- Digital Signal Processing Techniques
- Automatic Speech Recognition (ASR)
- Speech Recognition Approaches
- Text to Speech (TTS) system
- Speech Synthesis Approaches
- Language Models

**Lab Session:**

**NLP Applications**

- Lexicon, Dictionaries, thesaurus
- Transliteration, Spell Checker, Grammar Checker, Domain identification, Language identification
- Auto suggest/ Auto complete, Gender Prediction

- Machine Translation
- Neural machine translation
- Information extraction and Retrieval
- Question answering & dialogue agents
- Speech Technologies
- OCR, Hand Writing Recognition
- Indian Language Script Technology
- Language identification
- Auto suggest/ Auto complete, chat bots, Robotics

**Computer Vision (14 Hrs Theory + 16 Hrs Lab)**

**Session 14 & 15:**

- Introduction to Computer Vision
- Computer Vision and Natural Language Processing
- The Three R's of Computer Vision
- Basics of Image Processing
- Vision Level – Low, Mid & High

**Lab Assignments:** Load any .jpeg image and process the image using Open CV

**Session 16 & 17:**

- Edge Detection, Interest Points and Corners
- Image Classification
- Recognition, Bag of Features, and Large-scale Instance Recognition
- Transfer Learning

**Lab Assignments:** Load any image and classify the image and implement the edge detection

**Session 18: (2 Hrs of Theory and 4 Hrs of Lab)**

- Alex Net,
- ResNet,
- Image Net

**Lab Assignments:** Implement AlexNet, ResNet and Image Net on the data sets.

**Session 19 & 20:**
**Introduction to Object Detection Algorithms**

- YoLo (High Level Overview)
- RCNN
- Fast RCNN

- Faster RCNN
- Mask RCNN

**Lab Session**
**Applications of Computer Vision**

- Gender Prediction
- Image Mapping
- Face / Object Recognition
- Image Recreation
- Image Matching