Programme: B. Tech. (CSE)	Course Title: Deep Learning for Natural Language Processing			Course Code: CSE4221
Type of Course: Program Elective	Prerequisites: Programming with python, Basic Machine Learning			Total Contact Hours: 40 Theory + 0 Lab
Year/Semester: 4/Odd	Lecture Hrs/Week: 3	Tutorial Hrs/Week: 0	Practical Hrs/Week: 0	Credits: 3

Learning Objective:

A natural language is an indispensable instrument for human communication. Using natural language to communicate with one another is one of the most natural interactions. In books, newspapers, the internet, social media, etc., there is a great volume of text and audio containing information. Almost all knowledge known to mankind is available in the form of books. Therefore, it is essential to automatically extract knowledge from text. Recent advancements in the field of deep learning have enhanced the performance of numerous natural language processing (NLP) tasks. NLP has applications in a variety of fields, including finance, medicine, education, web search, text editing, advertising, emails, customer interaction, machine translation, personal assistance devices, politics, and knowledge representation. This course is designed to introduce students to contemporary NLP applications and technologies. Students should be able to design and deploy a real-world application by the end of the course.

Course Outcomes (COs):

On completion of this course, the students will have the ability to:		Bloom's Level
CO1	**Understand** the Deep Learning methods in Natural Language Processing	**2**
CO2	**Understand** and **apply** various modern tools for NLP application development	**4**
CO3	**Deploy** and **optimize** an application in a scalable manner for real-world problem	**5**
CO4	Apply NLP to **design** new applications	**6**

Course Topics:

UNIT and Content	Lecture Hours		COs
1. Introduction to Natural Language Processing			**CO1**
1.1. Introduction to NLP	**1**	**3**	
1.2. Applications of NLP	**2**		
2. Brief to traditional approaches		**4**	**CO1**
2.1. Rule-based approach.	**1**		
2.2. Traditional features.	**1**		
2.3. Hidden Markov Model (HMM), HMM for POS-Tagging.	**1**		
2.4. Introduction to NLTK.	**1**		
3. Word Vectors			**CO1, CO2**
3.1. Word vectors such as word2vec, Glove	**1**	**3**	
3.2. Applications of word vectors.	**1**		
3.3. Introduction to Gensim and Spacy.	**1**		
4. Neural Networks			

4.1. Introduction to Neural networks, Feed-Forward Neural Networks.	**1**	**5**	**CO1, CO2**
4.2. Recurrent Neural Networks (RNN).	**1**		
4.3. Long short-term memory (LSTM) and attention mechanism.	**1**		
4.4. Self-attention and Transformer.	**1**		
4.5. Introduction Jupyter Notebook	**1**		
5. Pre-trained Networks and fine-tuning			**CO3**
5.1. Pre-trained Networks such as BERT.	**2**	**10**	
5.2. Multilingual models mBERT, XLM-R, and applications.	**2**		
5.3. Fine-tuning pre-trained networks for downstream applications.	**3**		
5.4. Introduction to Pytorch-based open source libraries such as Huggingface transformer.	**3**		
6. Application Development, Deployment, and Recent Progress in NLP			**CO4**
6.1. Construct, debug and optimize transformer models for fundamental NLP tasks including text classification, named entity identification, and question answering.	**8**	**15**	
6.2. Real-world application development and deployment.	**2**		

6.3.	Make deployment-efficient transformer models utilizing techniques like distillation, pruning, and quantization.	**2**		
6.4.	Large language models and their applications in text, and image generations.	**3**		

Textbook References:

Textbook:

1. Daniel Jurafsky and James H. Martin, *Speech and Language Processing*, 3rd ed. Draft, 2021.
2. Leandro von Werra, Lewis Tunstall, and Thomas Wolf, *Natural language processing with transformers.* O'Reilly Media, Inc., 2022.
3. Delip Rao and Brian McMahon, *Natural language processing with PyTorch: build intelligent language applications using deep learning.* O'Reilly Media, Inc., 2019.

Reference books:

1. Jacob Eisenstein, *Natural language processing*. MIT Press, 2018.
2. Yoav Goldberg, *A primer on neural network models for natural language processing.* Journal of Artificial Intelligence Research, 2016.
3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, *Deep learning.* MIT Press, 2016.
4. Other related Research papers.

Evaluation Methods:

Item	**Weightage (%)**	**Associated CO**
Assignment 1	2	CO1
Assignment 2	8	CO1, CO2
Quiz 1	5	CO1, CO2
Mid Term	20	CO1, CO2
End Term	40	CO1, CO2, CO3, CO4

Project	25	CO2, CO3, CO4

CO and PO Correlation Matrix (CSE):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1		1												
CO2	1	1	1											1	1
CO3	1	2	3	1	1	2						1	1	2	3
CO4	1	3	3	2	1	3		1			1	2	1	2	3

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