



ST. VINCENT PALLOTTI COLLEGE OF ENGINEERING & TECHNOLOGY, NAGPUR

(An autonomous institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

M. Tech Scheme of Examination & Syllabus 2025-26

COMPUTER SCIENCE AND ENGINEERING (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

SEMESTER II

Sr No.	Course Code	Course Title	Hours Per Week			Credits	Maximum Marks		Total	Minimum Passing Marks	No. of Hrs for ESE
			L	T	P		Continual Assessment	End Sem Examination			
1	25AM201T	Reinforcement Learning and Applications	3	-	-	3	40	60	100	50	3
2	25AM201P	Reinforcement Learning and Applications Lab	-	-	4	2	25	25	50	25	-
3	25AM202T	High Performance Computing for AI-ML	3	-	-	3	40	60	100	50	3
4	25AM202P	High Performance Computing for AI-ML Lab	-	-	4	2	25	25	50	25	-
5	25AM203T	Research Methodology	2	-	-	1	20	30	50	25	1.5
6	25AM204T	Program Elective-II	3	-	-	3	40	60	100	50	3
7	25AM205P	Technical Seminar-II	-	-	6	3	50	-	50	25	-
8	25AM206P	Mini Project – II	-	-	6	3	50	-	50	25	-
Total			11	-	16	20	290	260	550		

		July 2025	1.0	Applicable for 2025-26
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A. Basket for Program Elective Courses (PEC)

Semester	Course Code	Name of Course	Credit
II	25AM204T (i)	Introduction to Large Language Models	3
II	25AM204T (ii)	Advanced R Programming for Data Analytics in Business	3

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SECOND SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25AM201T	Reinforcement Learning and Applications	3	-	-	3	40	60	100

Course Objectives	Course Outcomes
This course is intended <ol style="list-style-type: none">To understand the fundamental theory of Reinforcement Learning.To develop the ability to model real-world sequential decision-making problems and identify suitable RL frameworks for solving them.To distinguish between model-based and model-free reinforcement learning approachesTo formulate, implement, and evaluate RL algorithms	Students will be able to <ol style="list-style-type: none">Apply the core concepts of Reinforcement Learning, including agents, environments, states, actions, rewards, policies, and value functions.Analyze and apply Dynamic Programming.Develop proficiency in model-free learning techniques.Explore advanced Reinforcement Learning methods.Apply Reinforcement Learning algorithms to real-world domains.
Unit I : Introduction to RL and Elements of RL	[9Hrs]
What is RL, Differences from Supervised/Unsupervised Learning, Use Cases, Agent, Environment, States, Actions, Rewards, Policy, Value functions	
Unit II : Dynamic Programming	[9Hrs]
Definition, Transition Probability, Reward Function, Discount Factor, Policy Evaluation, Policy Iteration, Value Iteration	
Unit III : Temporal Difference Learning	[9Hrs]
Exploring starts, Prediction & Control using Monte Carlo, TD (0), SARSA, Q-Learning	
Unit IV : Policy Gradient Methods	[9Hrs]
Deep Q-Networks, Experience Replay, Target Networks, REINFORCE, Actor-Critic, Advantage Estimation	
Unit V : Application and RL Tools	[9Hrs]
RL in Robotics, Games (Atari), Recommender Systems, Trading, OpenAI Gym, Stable-Baselines, RLlib	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Reinforcement Learning: An Introduction	Richard S. Sutton, Andrew G. Barto	2nd Edition	The MIT Press
2.	Deep Reinforcement Learning with Python: With PyTorch, TensorFlow and OpenAI Gym	Nimish Sanghi	1st Edition	Apress
3.	Deep Reinforcement Learning Hands-On	Maxim Lapan	1st Edition	Packt Publishing

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Reinforcement Learning: An Introduction	Richard S. Sutton, Andrew G. Barto	2nd Edition	The MIT Press
2.	Neuro-Dynamic Programming	Dimitri P. Bertsekas, John N. Tsitsiklis	1st Edition	Athena Scientific
3.	A Course in Reinforcement Learning	Dimitri P. Bertsekas	2nd Edition	Athena Scientific

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Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25AM201P	Reinforcement Learning and Applications Lab	-	-	4	2	25	25	50

Course Objectives	Course Outcomes
This course is intended 1. To enable students to gain hands-on experience in implementing Reinforcement Learning algorithms by installing and running standard environments.	Students will be able to 1. Install, configure, and run reinforcement learning environments 2. Implement state-value and action-value functions 3. Design and implement tabular Q-learning algorithms and evaluate agent performance in discrete environments. 4. Train and evaluate an intelligent agent 5. Build, train, and optimize Deep Q-Network (DQN) models using neural networks for complex state spaces.

Expt. No.	Title of the experiment
1	Installing and running environments like CartPole, FrozenLake
2	Coding state-value and action-value estimation
3	Implementing policy evaluation and improvement loops
4	Estimating value functions using MC Sampling
5	Implementing tabular Q-learning for FrozenLake
6	Build DQN for CartPole using TensorFlow/Keras/PyTorch
7	Implement Actor-Critic for continuous action space
8	Train an agent to play a simple Atari or Grid-based game

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Reinforcement Learning: An Introduction	Richard S. Sutton, Andrew G. Barto	2nd Edition	The MIT Press
2.	Deep Reinforcement Learning with Python: With PyTorch, TensorFlow and OpenAI Gym	Nimish Sanghi	1st Edition	Apress
3.	Deep Reinforcement Learning Hands-On	Maxim Lapan	1st Edition	Packt Publishing

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Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25AM202T	High Performance Computing for AI-ML	3	-	-	3	40	60	100

Course Objectives	Course Outcomes
<p>This course is intended</p> <ol style="list-style-type: none">To equip students with a comprehensive understanding of High-Performance Computing (HPC)To emphasize the use of modern HPC tools, libraries, and cloud platforms to build scalable solutions.	<p>Students will be able to</p> <ol style="list-style-type: none">Compare and analyze HPC architectures and parallel processing modelsDesign and implement multithreaded and parallel programsApply CUDA programming concepts to efficiently utilize GPU hardware for compute-intensive tasks.Implement distributed deep learning models using data and model parallelism techniquesEvaluate scalability and performance of HPC-based AI systems

Unit I : Introduction to HPC	[9Hrs]
What is HPC, Need in AI/ML, Clusters, Supercomputers, CPUs vs GPUs, TPUs, SIMD, MIMD Concepts	
Unit II : Model Building	[9Hrs]
Multithreading, Parallelism Models, Race Conditions, Threads, CUDA Basics, Threads, Blocks, Warps	
Unit III : HPC Tools and Libraries	[9Hrs]
Open MP, MPI, NCCL, TensorFlow with GPU, AWS EC2, Azure GPU VMs, Google TPUs	
Unit IV : Distributed Deep Learning	[9Hrs]
Data Parallelism, Model Parallelism, Horovod, TensorFlow Multi-GPU, Memory Bandwidth, Profiling, Bottleneck	
Unit V : Benchmarking and Scalability with case studies	[9Hrs]
FLOPs, Speedup, Amdahl's Law, Scalability Techniques, HPC in Genomics, Autonomous Driving, Real-time Syst	

Text Books

S.N	Title	Authors	Edition	Publisher
1	Parallel and High-Performance Computing in Artificial Intelligence	Mukesh Raghuvanshi, Pradnya Borkar, Rutvij H. Jhaveri & Roshani Raut	1st Edition	Auerbach Publications / CRC Press
2.	Foundations of High-Performance Computing	Oscar Diez	1st Edition	Elsevier
3.	GPU-Accelerated Deep Learning: Essential GPU Ideas, Deep Learning Frameworks, and Optimization Approaches	Ramchandra S. Mangrulkar & Pallavi Vijay Chavan	1st Edition	Apress

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Foundations of High-Performance Computing	Oscar Diez	1st Edition	Elsevier
2.	Parallel Programming for Modern High Performance Computing Systems	Pawel Czarnul	1st Edition	Chapman & Hall/CRC
3.	Multicore and GPU Programming: An Integrated Approach	Gerassimos Barlas	2nd Edition	Elsevier

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Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25AM202P	High Performance Computing for AI-ML Lab	-	-	4	2	25	25	50

Course Objectives	Course Outcomes
<p>This course is intended</p> <ol style="list-style-type: none">To introduce students to GPU architecture and parallel programming concepts.To teach basic CUDA programming skills including kernel design and memory management. To enable students to write parallel algorithms exploiting GPU hardware.To develop understanding of thread hierarchy and memory hierarchy in CUDA	<p>Students will be able to</p> <ol style="list-style-type: none">Install and configure GPU computing environments using CUDA, cuDNN, and deep learning frameworks, and develop CUDA programsTrain and optimize deep learning models using GPU acceleration, implement multi-GPU and distributed training using frameworksDesign, evaluate, and deploy scalable AI solutions using HPC stacks,

Expt. No.	Title of the experiment
1	Install CUDA, cuDNN, TensorFlow GPU
2	Write CUDA programs to demonstrate parallelism
3	Parallel code for matrix multiplication or other computations
4	Train deep learning models with GPU acceleration
5	Use TensorFlow or PyTorch with multiple GPUs
6	Implement distributed training using Horovod or Spark ML
7	Compare CPU vs GPU performance, profiling tools
8	Deploy AI models using cloud GPU instances
9	Build a scalable deep learning solution using HPC stack

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Parallel and High-Performance Computing in Artificial Intelligence	Mukesh Raghuvanshi, Pradnya Borkar, Rutvij H. Jhaveri & Roshani Raut	1st Edition	Auerbach Publications / CRC Press
2.	Foundations of High-Performance Computing	Oscar Diez	1st Edition	Elsevier
3.	GPU-Accelerated Deep Learning: Essential GPU Ideas, Deep Learning Frameworks, and Optimization Approaches	Ramchandra S. Mangrulkar & Pallavi Vijay Chavan	1st Edition	Apress

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Foundations of High-Performance Computing	Oscar Diez	1st Edition	Elsevier
2.	Parallel Programming for Modern High Performance Computing Systems	Pawel Czarnul	1st Edition	Chapman & Hall/CRC
3.	Multicore and GPU Programming: An Integrated Approach	Gerassimos Barlas	2nd Edition	Elsevier

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SECOND SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25AM203T	Research Methodology	2	-	-	1	20	30	50

Course Objectives	Course Outcomes
This course is intended <ol style="list-style-type: none">To enable students to define research problems, learn to evaluate literature and possibly to formulate effective solutions.To prepare students either for a research thesis or for an industry-based project.To provide oral and written communication skillsTo inculcate a strict adherence to the principles of research ethics and values.	Students will be able to <ol style="list-style-type: none">Explain the basic concepts and types of research • Develop research design and techniques of data analysisDevelop critical thinking skills and enhanced writing skillsApply qualitative and quantitative methods for data analysis and presentationImplement healthy research practice, research ethics, and responsible scientific conduct

Unit I :	[10Hrs]
A group discussion on what is research; Overview of research, Literature survey , Experimental skills,Data analysis, Modelling skills;	
Unit II :	[10Hrs]
Technical writing; Technical Presentations; Creativity in Research, Creativity in Research; Group discussion on Ethics in Research	
Unit III :	[10Hrs]
Design of Experiments, Intellectual Property, Department specific research discussions	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Research Design: Qualitative, Quantitative, and Mixed Methods Approaches	John W. Creswell and J. David Creswell	6th Edition	Sage Publications
2.	Scientific Research Methodology: Principles, Tools, and Techniques	Sanjeev Singh Yadav, Shivani Gupta & Atul Kumar Choudhary	1st Edition	CRC Press
3.	Research Methodology and Scientific Writing	C. George Thomas	2nd Edition	Springer

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Research Design and Methods – A Process Approach	Bordens, K. S. and Abbott, B. B	11th Edition	McGraw-Hill
2.	Research Methodology: A Step by Step Guide for beginners	Ranjit Kumar	4th Edition	CRC Press
3.	Research Methodology and Scientific Writing	C. George Thomas	2nd Edition	Springer

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Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
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25AM204T(i)	PE-II Introduction to Large Language Models	3	-	-	3	40	60	100

Course Objectives	Course Outcomes
<p>This course is intended</p> <ol style="list-style-type: none"> To introduce foundational principles behind Large Language Models (LLMs) To explore prompt engineering, fine-tuning, and in-context learning for performance enhancement. To study architecture deployment and memory solutions for LLMs and diffusion models. To enable students to build applications using LLMs, vector databases, and evaluate outputs using suitable metrics 	<p>Students will be able to</p> <ol style="list-style-type: none"> Identify and explain various state-of-the-art LLMs and their architectures Implement prompt engineering, in-context learning, and fine-tuning strategies in LLM-driven applications. Deploy and serve LLMs and manage memory-efficient storage using vector databases Evaluate LLM-based applications such as chatbots, code generation, and summarization using modern evaluation metrics.

Unit I :	[9Hrs]
Introduction to NLP (NLP Pipeline, Applications of NLP), Introduction to Statistical Language Models, Statistical Language Models: Advanced Smoothing and Evaluation	
Unit II :	[9Hrs]
Introduction to Deep Learning (Perceptron, ANN, Backpropagation, CNN), Introduction to PyTorch, Word Representation , Word2Vec fastText GloVe, Tokenization Strategies	
Unit III :	[9Hrs]
Neural Language Models ,CNN, RNN, LSTM, GRU, Sequence-to-Sequence Models, Greedy Decoding, Beam search, Other Decoding Strategies: Nucleus Sampling, Temperature Sampling, Top-k Sampling, Attention in Sequence-to-Sequence Model	
Unit IV :	[9Hrs]
Pre-Training Strategies: ELMo, BERT (Encoder-only Model), Pre-Training Strategies: Encoder-decoder and Decoder-only Models, Introduction to HuggingFace	
Unit V :	[9Hrs]
Instruction Tuning, Prompt-based Learning, Advanced Prompting Techniques and Prompt Sensitivity, Alignment of Language Models with Human Feedback (RLHF)	

Text Books

S.N	Title	Authors	Edition	Publisher
1.	Speech and Language Processing	Dan Jurafsky & James H. Martin	3rd Edition	Pearson
2.	Introduction to Large Language Models	Tanmoy Chakraborty	1 st Edition	Wiley India
3.	Natural Language Processing with Transformers	Lewis Tunstall, Leandro von Werra & Thomas Wolf	1st Edition	O'Reilly Media

Reference Books

S.N	Title	Authors	Edition	Publisher
1.	Foundations of Statistical Natural Language Processing	Christopher D. Manning & Hinrich Schütze	1st Edition	MIT Press
2.	Natural Language Processing: Neural Networks and Large Language Models	Tong Xiao & Jingbo Zhu	1st Edition	NiuTrans
3.	Natural Language Processing	acob Eisenstein	1st Edition	The MIT Press

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Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
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25AM204T(ii)	PE-II Advanced R Programming for Data Analytics in Business	3	-	-	3	40	60	100

Course Objectives	Course Outcomes
<p>This course is intended</p> <ol style="list-style-type: none"> 1. Provide a strong foundation in R programming fundamentals 2. Enable students to perform data manipulation and transformation 3. Introduce data visualization principles and enable students to create and customize basic plots using base R. 	<p>Students will be able to</p> <ol style="list-style-type: none"> 1. Demonstrate proficiency in R programming fundamentals. 2. Create, customize, and interpret basic data visualizations in R. 3. Design advanced and publication-quality visualizations using ggplot2. 4. Perform exploratory data analysis (EDA) and data wrangling. 5. Handle and manipulate complex date and time objects in R.

Unit I : Advanced R programming for Data Science: Introduction and Background [9Hrs]

Fundamentals of R: Installation and set-up, set working directory, packages, and libraries; R operators: Arithmetic, assignment, comparison, and logical operators; Working with different data types; Vector creation and manipulation; Miscellaneous functions: Sequence, repetition, sorting, generate random numbers, user-defined functions, lapply, sapply, and tapply function; Factor variables, Indexing, Data coercion, conditional statements

Unit II : Introduction to Data Visualization with R: [9Hrs]

Basic Plotting types: Barchart, Pie Chart, Histogram, Density plot, Boxplot; Plot customization: Adding legend, Adding color in plots, Adding axis labels and chart title, Modifying axis and scales; Overlay plots in R

Unit III : Advanced Data Visualization with ggplot2: [9Hrs]

Key components; Color, size, shape, and other aesthetic attributes; Faceting: Wrap faceting and Grid faceting; Plot geoms: Adding a smoother to a plot, Boxplots, jitterplots, histogram, frequency polygons, Time series with line and path plots; Modifying the axes; Quick plots; Correlation matrix with ggplot.

Unit IV : Exploratory Data Analysis (EDA) and Data Wrangling: [9Hrs]

Reading and writing the data, exporting, and saving a dataframe; Data handling and cleaning: Recording the variables, dealing with NAs, adding a row and column to the dataframe, wide to long data formats, merging the dataframes.

Unit V : Handling Complex Date and Time Objects: [9Hrs]

Getting the current date and time, POSIX classes (POSIXct and POSIXlt), Parsing dates, Date and time components, Dates not in Standard Format; Operations on dates: subtract/add, finding difference, generating a sequence, truncate; Time zones; Time intervals: Interval and overlaps; Periods and durations; Date arithmetic; Rounding the dates

Text Books

S.N	Title	Authors	Edition	Publisher
1.	R for Data Science	Hadley Wickham & Garrett Golemund	2nd Edition	O'Reilly Media
2.	Introduction to Data Science: Data Wrangling and Visualization with R	Rafael A. Irizarry	2nd Edition	Chapman & Hall/CRC Press
3.	Data Wrangling with R	Gustavo R. Santos	1st Edition	Packt Publishing Limited

S.N	Title	Authors	Edition	Publisher
1.	Introduction to Data Science: Data Wrangling and Visualization with R	Rafael A. Irizarry	2nd Edition	Chapman & Hall/CRC Press
2.	Data Wrangling with R	Gustavo R. Santos	1st Edition	Packt Publishing Limited
3	R Cookbook	JD Long & Paul Teetor	2nd Edition	O'Reilly Media

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Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
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25AM205P	Technical Seminar-II	-	-	6	3	50	-	50

Course Objectives	Course Outcomes
This course is intended 1. To offer students a chance to investigate and expand their understanding of innovative and emerging technologies.	Students will be able to 1. Demonstrate an understanding of the fundamental concepts, trends, and significance of various emerging technologies. 2. Analyse the applications and impact of emerging technologies in solving real world problems across different domains 3. Develop confidence and self-reliance in exploring, experimenting with, and presenting ideas related to emerging technologies.

Students are required to present seminars on various emerging technologies to explore and deepen their knowledge in specific technical fields, current trends, and industry advancements, while also developing and demonstrating prototypes of selected topics, thereby enhancing their expertise, critical thinking, and problem-solving abilities within their chosen domain.

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Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
25AM206P	Mini Project – II	-	-	6	3	50	-	50

Course Objectives	Course Outcomes
<p>This course is intended to</p> <p>Provide an opportunity for the students to apply the knowledge, develop the skills and provide hands-on experience on a practical based project.</p>	<p>Students will be able to:</p> <ol style="list-style-type: none">1. Apply theoretical knowledge to address real-world problems, showcasing research, problem-solving, and critical thinking skills.2. Effectively communicate project findings and demonstrate proficiency in project management and interdisciplinary learning.3. Develop practical experience, ethical considerations, and the ability to adapt to challenges in a hands-on learning environment.4. Develop the ability to document the program, methodologies and results effectively in the form of project report.

Student need to build a project by successfully applying their academic knowledge to solve practical problems, demonstrating research, critical thinking, communication skills in a real-world context and prepare the project report.

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